

New Scientist

WEEKLY 2 October 2021

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THE SOLAR SYSTEM

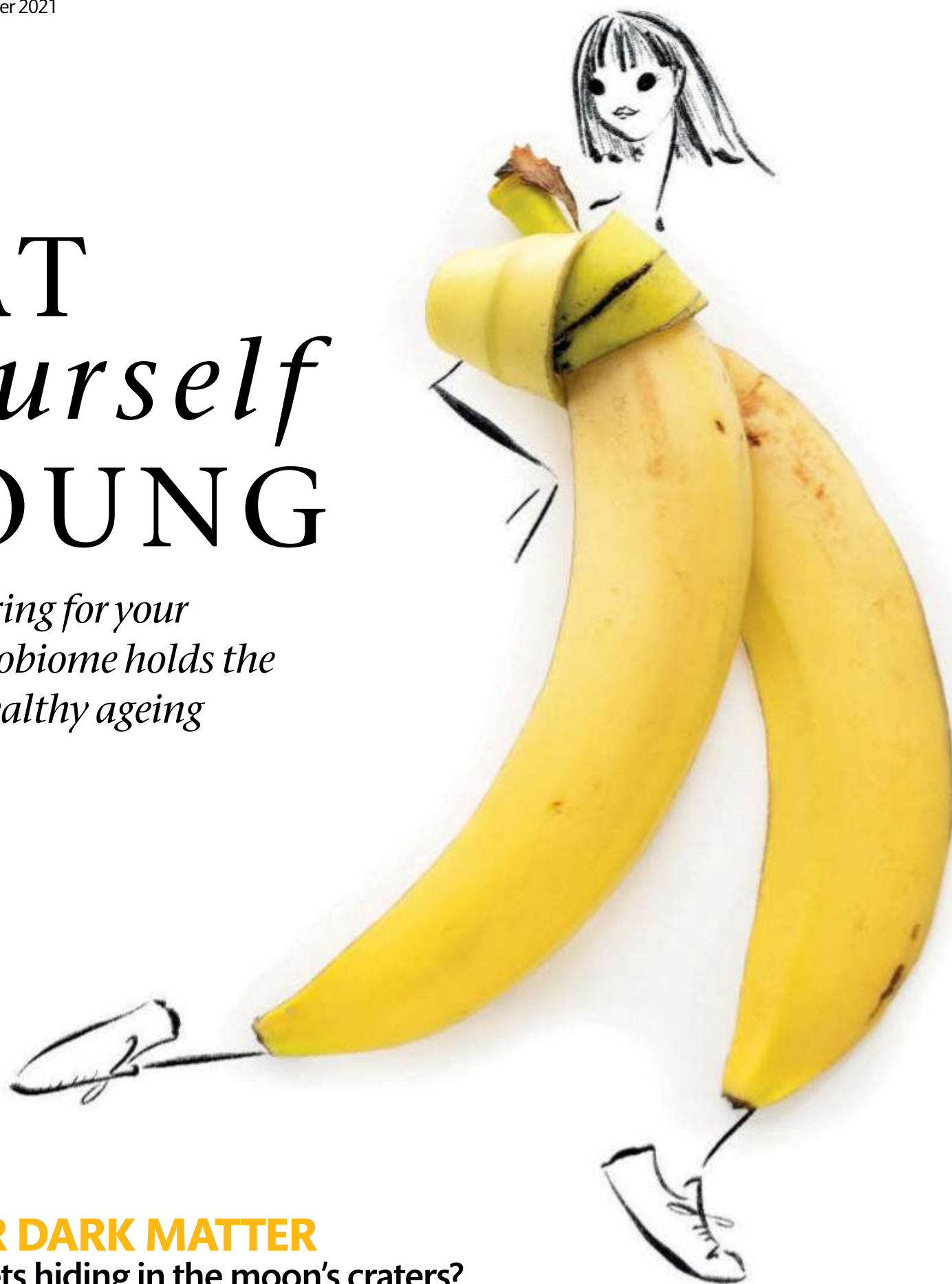
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GOES ON SALE

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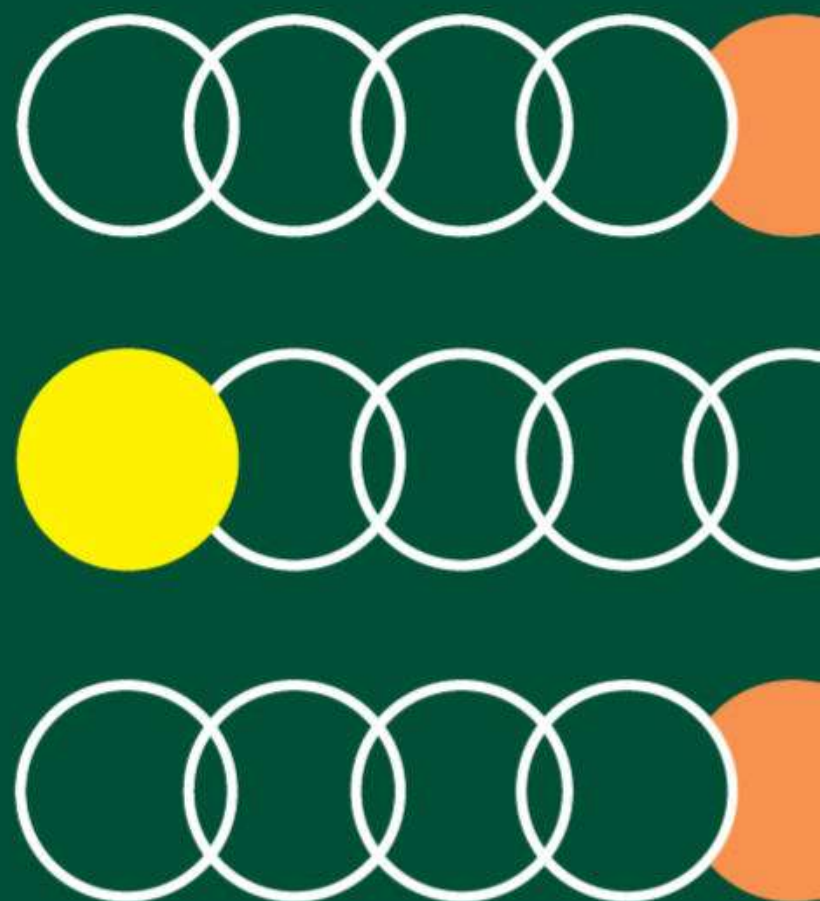


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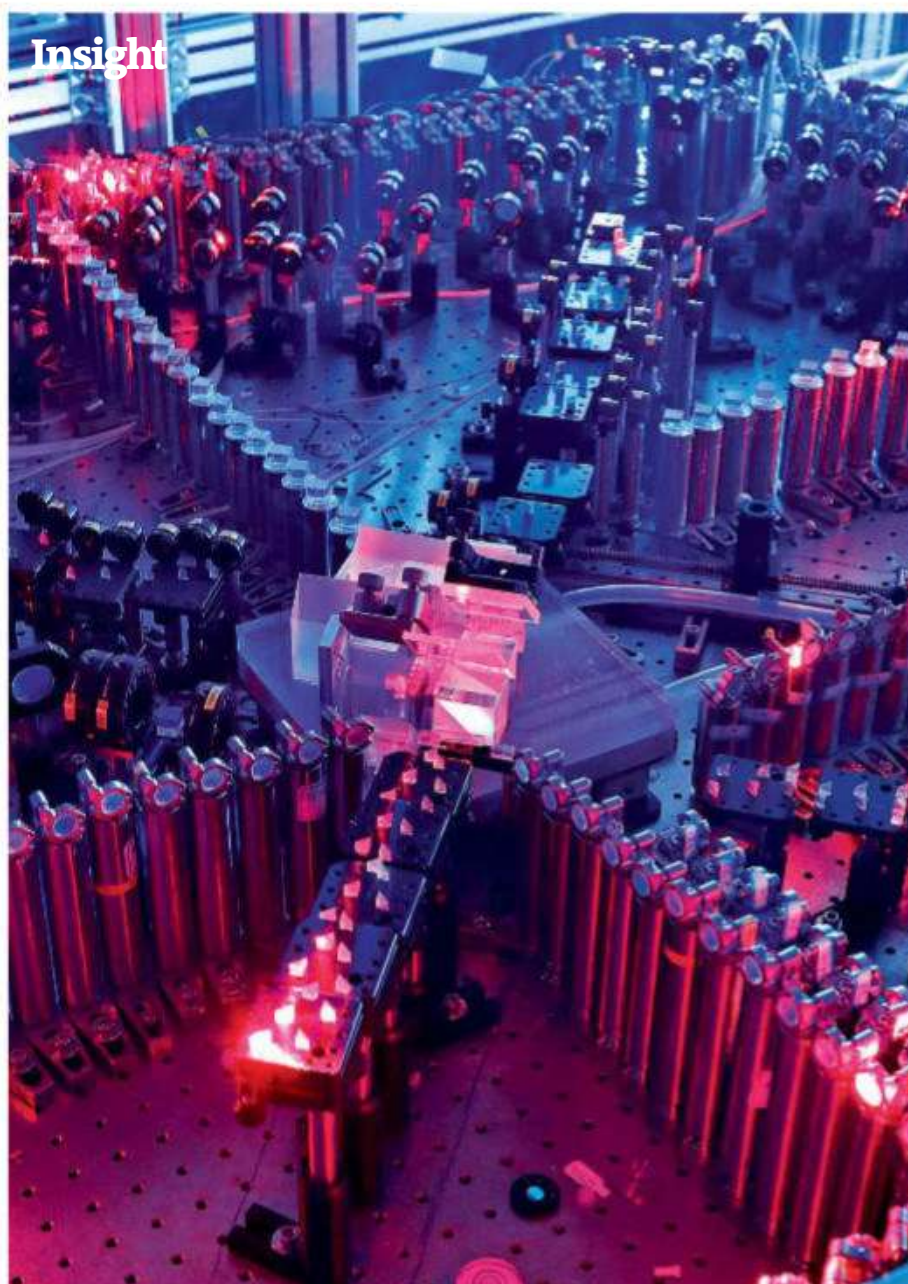
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Virtual event

Five patterns that explain reality

Our understanding of the world – from the history of the universe to chemical reactions – is based on patterns. In this talk, science writer Brian Clegg will explore five of the most crucial: the periodic table, the cosmic microwave background, Feynman diagrams, number lines and the DNA double helix. Join us at 6pm BST (1pm EDT) on 7 October. Tickets available online.

newscientist.com/ns-events

Academy

Consciousness and general relativity

New Scientist Academy is an online platform that can give you a deeper understanding of the biggest ideas in science. We are now offering two brand new courses: one looking at general relativity, the other at the mystery of consciousness.

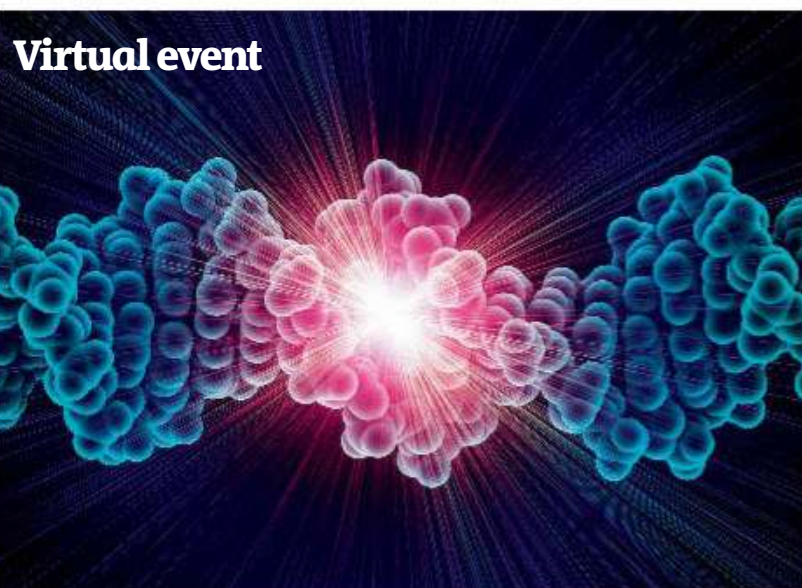
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Podcast

Weekly

Imagine going your whole life without being able to smell – then suddenly you can. The team tells the story of a woman who gained a sense of smell aged 24. We also hear about the need for a joined-up approach to tackling the climate and biodiversity crises. Plus: a city-wide quantum communications network in China, and what is driving the UK's fuel crisis.

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The double helix DNA is a fundamental pattern inside all of us



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Eye on the sky The ALMA telescope mapped planetary nurseries

Video

Dinosaur swagger

When the earliest dinosaurs began to walk upright, it seems that some may have wagged their tails to increase the efficiency of their movement. Watch a simulation of a bipedal dinosaur that lived about 220 million years ago and see its swagger in action. More discoveries and incredible science can be found every week on our channel – don't forget to subscribe.

youtube.com/newscientist

Newsletter

Launchpad

Sign up for reporter Leah Crane's fabulous newsletter on space science. In the latest one, she looks at newly unveiled maps of the discs of dust and gas where planets form around five nearby stars. There were a lot of differences between them, but surprisingly they all contained lots of cyanide molecules.

newscientist.com/nslaunchpad

Newsletter

“Despite being terrible for us, cyanides seem to be good for kick-starting the chemistry of life”



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Our tricky solar system

Another piece of the cosmic puzzle has fallen into place, but many mysteries remain

ABOUT 4.5 billion years ago, a gigantic cloud of dust and gas floating through space collapsed in on itself, going on to form the sun, the planets and everything else in our solar system. That we are reasonably certain of this fact is a triumph for science, but our cosmic neighbourhood has so many more secrets for us to reveal.

Take what seems like, on face value, a pretty easy question: how did the planets get to where they are today? We know that the most obvious answer, that they formed where they currently sit, is wrong, because the two outermost planets, Uranus and Neptune, are too large to have developed at the thin edge of the solar system's protoplanetary disc.

That is why many astronomers favour a scenario in which Jupiter, the largest planet, throws itself about the early solar

system, knocking all the other planets here and there until things settle down. There are a few varieties of this idea: Jumping Jupiter, Grand Tack and the Nice model (named for the French city, not its pleasantness). All of them have issues, but on a broad scale, they produce the solar system as we know it today.

"An ancient meteorite seems to show signs of a Jupiter-driven mix-up in the early solar system"

These models, nice as they might be, are built on a whole heap of necessary assumptions, simply because we can't go back in time and see if the maths checks out. But now, researchers have done the next best thing, discovering an ancient meteorite that seems to have telltale signs

that a Jupiter-driven mix-up really occurred (see page 19).

If this piece of the cosmic puzzle has finally fallen into place, there are still many looking for a home. Finding signs of past (see page 16) or present (page 15) life on another planet or moon would be incredible, but little green microbes aren't the only game in town. How planets put themselves together is another favourite head-scratcher (little by little or big bits all at once are the main options) and theorists are always dreaming up new ones, such as the question of whether the moon is hiding secret signs of ancient black holes (see page 46).

If you are impatient for answers, remember that many of these things happened billions of years ago, so waiting a little longer won't hurt. ■

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PAST PERFORMANCE

	Aug 16 – Aug 17	Aug 17 – Aug 18	Aug 18 – Aug 19	Aug 19 – Aug 20	Aug 20 – Aug 21
Net Asset Value	19.1%	8.7%	-4.9%	-18.5%	56.2%
Share Price	28.1%	14.0%	-6.9%	-25.4%	73.8%
FTSE All Share Total Return Index	14.3%	4.7%	0.4%	-12.6%	26.9%

Past performance is not a reliable indicator of future returns.

Source: Morningstar as at 31.08.2021, bid-bid, net income reinvested.

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the field **p18**

Prehistoric stride
Dinosaurs swished
their tails as they
stepped out **p22**

Nothing to see
Make-up tips can
let you dodge face
recognition **p22**

Friendly face
Hyenas bob their
heads when they
want to play **p23**



FLORIAN GAERTNER/PHOTOTHEK VIA GETTY IMAGES

A protest for climate justice in Berlin on 24 September

CO₂ price and create a strong expansion of renewable energies.”

However, the three parties will have to compromise on political differences. The FDP have said the only approach for climate action should be carbon pricing, ruling out regulations such as a ban on new petrol and diesel car sales. In contrast, the Greens want a ban by 2030. The Greens have also said they won't form a government without a major shift on climate action, says Kaiser.

For Höhne, the biggest issue is the coalition's target for how much new wind and solar power capacity to build each year. Annual growth in renewable power has stagnated under outgoing chancellor Angela Merkel's government in recent years.

Another question is whether to bolster Germany's new carbon-pricing scheme for buildings and transport, which the Green party want to see raised from €25 a tonne of CO₂ to €65. The parties at least agree that the revenues of the scheme should be redistributed to poorer people.

A government isn't expected to take shape until Christmas at the earliest, but the coalition could still influence the COP26 climate summit in November. Kaiser says it could signal that it is willing to support a global coal phase-out statement being prepared by the UK, which is hosting the conference in Glasgow.

Whatever the fine print of the coalition agreement, a greener Germany is expected. “This election is good news for the climate compared to the previous government,” says Höhne. Kaiser says time will tell whether Scholz delivers on his promise of being a climate chancellor, a title he says Merkel failed to earn. “Herr Scholz needs to deliver on it,” he says. ■

Climate change

A greener Germany?

Talks to form a new ruling coalition after the country's election will see climate change top the agenda, says **Adam Vaughan**

A NEW government is set to take shape in Germany and is expected to be far more ambitious on climate change, with extra support for renewables and action against fossil fuels. But the three parties hoping to form a ruling coalition must first compromise on their different visions of how to do that, which could mean months of talks.

Amid climate protests, the centre-left Social Democratic Party (SPD) won 25.7 per cent of the vote on 26 September, narrowly beating the incumbent conservative Christian Democratic Union-Christian Social Union (CDU/CSU) group.

Olaf Scholz, the SPD's candidate to lead Germany, who pitched himself as the “climate

chancellor” during campaigning, has claimed victory and wants to form a coalition with the Green party, which won a record share of the vote, and the liberal Free Democratic Party (FDP).

Climate change will be at the top of the agenda in those coalition talks. “It was quite remarkable because climate change was one of the top two issues at the centre of the election campaign,” says Martin Kaiser at Greenpeace Germany. Apart from the far right, all the parties in the campaign committed to meeting the Paris Agreement's goal of holding the global temperature rise to 1.5°C, says Niklas Höhne at the NewClimate Institute in Germany.

On the table in the talks are

Germany's domestic carbon-pricing schemes, bringing forward its belated 2038 coal phase-out date and how to issue stronger support for wind and solar power.

“If they are serious, they must get serious now,” says Ottmar Edenhofer at the Potsdam

“Climate change was one of the top two issues at the centre of the German election campaign”

Institute for Climate Impact Research in Germany. “The new government must tackle a targeted energy tax reform, make the carbon dioxide price the guiding instrument, introduce a fair social compensation in the

Should you get a booster?

As the UK and US embark on large-scale coronavirus vaccine booster campaigns, **Graham Lawton** considers the evidence on whether you should get another shot

OVER the next few months, about 30 million fully vaccinated people in the UK will be invited to have a third dose of a covid-19 vaccine. The surprise decision to run such a large booster campaign – everyone over 50 is included – was made off the back of multiple lines of evidence, none of them definitive. So what is the rationale behind it? And if you are offered a booster, should you take it?

The UK isn't the only country looking to roll out third doses for a large portion of the population. Last week, the US Centers for Disease Control and Prevention endorsed the use of booster shots for people aged 65 and over, and for those with underlying health conditions or in jobs with a high risk of exposure to the virus.

The UK government's decision was based on advice from the Joint Committee on Vaccination and Immunisation (JCVI), which says the move is "precautionary". The JCVI itself was largely guided by an ongoing clinical trial called COV-Boost, based at the University Hospital Southampton NHS Foundation Trust, UK.

In June, COV-Boost recruited 2833 people aged 30 and over who were already double vaccinated with either the Pfizer/BioNTech or Oxford/AstraZeneca vaccines. They all received a third dose of one of seven covid-19 vaccines – Pfizer/BioNTech, Oxford/AstraZeneca, Moderna, Novavax, Valneva, Janssen and Curevac – or a control, a vaccine against meningitis. Half of the recruits were over 70 and a "decent number" of those were over 80, says chief investigator Saul Faust. Half had received Pfizer/BioNTech for their first two doses and half Oxford/AstraZeneca.

Over the next four weeks, the volunteers kept a record of any side effects and on day 28 came in



A booster vaccination being given in Derby, UK, last week

for a blood test to measure their antibody levels, T-cell responses and also a "killing assay" to see how potent their blood was at neutralising the virus.

According to Faust, some of the vaccines produced "several-fold" increases in antibody levels and also improved T-cell responses, suggesting that they significantly strengthen protection against the virus. The vaccines were well tolerated in the small number of people in the trial.

The full results from the trial are expected in October, but the JCVI evidently saw enough in the interim results to give the green light to a booster campaign. Its booster of choice is the Pfizer/BioNTech vaccine, to be given at least six months after a person's second shot. A half dose of the Moderna vaccine – which like Pfizer/BioNTech is an mRNA vaccine – can also be used. People who can't take an mRNA vaccine

because of adverse reactions can have the Oxford/AstraZeneca vaccine as a booster.

The decision to go ahead was widely welcomed by scientists and medics. Neil Ferguson at Imperial College London said on Twitter that the booster campaign should help the UK avoid another lockdown this winter.

The decision doesn't mean boosters will become an annual

"Having a booster vaccination won't overload the immune system. It's not a credible concern"

event. "Our advice does not imply there will be future booster programmes," says Anthony Harnden, deputy chair of the JCVI.

We can be confident that the boosters are acceptably safe, says Faust. "I know they [the JCVI] will be taking the side effects into account when they make their recommendations." However, the trial didn't include enough people to pick up rare adverse events such as the blood-clotting disorders

occasionally seen with the Oxford/AstraZeneca vaccine.

The JCVI also considered data from Public Health England showing that vaccine-induced protection starts to fade 10 weeks after the second dose. After 20 weeks, protection against symptomatic disease falls from about 90 per cent to 70 per cent with Pfizer/BioNTech and from 65 per cent to 50 per cent with Oxford/AstraZeneca. Protection against hospitalisation also wanes slightly. The decline becomes more pronounced with age.

Booster campaigns are also supported by data from Israel, which started the world's first booster campaign in August amid a surge of infections among double-vaccinated people. "They were on an extremely bad trajectory," says Sarah Walker, chief investigator of the UK's COVID-19 Infection Survey. "There is no doubt that after they introduced boosters, their hospitalisation rate dropped."

Concerns have also been raised that existing vaccines don't adequately protect against the delta variant, which is now the dominant strain in the UK, and that boosters may have to be modified to deal with it or other "variants of concern". These fears are unjustified, says Sharon Peacock, executive director of the COVID 19 Genomics UK Consortium. "The vaccines are really effective against the variants of concern that are circulating," she says.

That also heads off another worry around boosters, the immunological phenomenon called original antigenic sin. This is when a modified vaccine reawakens an old immune response rather than provoking a new one, and it could render booster shots designed to target future variants ineffective. So it is

Tomatoes made with CRISPR gene editing go on sale

Michael Le Page

good news that, for the time being, current vaccines are doing pretty well against newer variants.

Concerns have been raised in the past as well about multiple dosing of the Oxford/AstraZeneca vaccine, because repeated exposure to the virus vector used to deliver the active ingredient could elicit a harmful immune response. Results so far suggest that this isn't a problem with a third dose, says Faust.

There is also no evidence that having booster vaccinations can somehow "overload" the immune system or produce a diminishing response over time. "That's not a credible concern. It won't overload the immune system," says Sarah Gilbert at the University of Oxford, who co-developed the Oxford/AstraZeneca vaccine.

All of this points squarely in one direction. "If you get called up for your booster vaccine, get it," says Roger Kirby, president of the UK's Royal Society of Medicine.

The booster campaign isn't just about individual protection, says David Oliver, a consultant physician at the Royal Berkshire Hospital, UK, but also about safeguarding public health and preventing hospitals from being overwhelmed this winter.

Some people, however, have chosen to decline their third dose because of issues around vaccine equity. So far, only 2.2 per cent of people in low-income countries have received at least one dose.

Tedros Adhanom Ghebreyesus, director-general of the World Health Organization, has called for a moratorium on booster shots until the end of the year, to enable every country to vaccinate 40 per cent of its population. But this requires political will from wealthy nations – if you decline your shot, it won't be sent to a country that needs it more. ■

FOR the first time ever, you can buy a food altered by CRISPR gene editing – at least, if you live in Japan, where the Sicilian Rouge High GABA tomato is now on sale.

"We started shipping the tomatoes on September 17," says Minako Sumiyoshi at Japanese start-up Sanatech Seed, which is selling the tomatoes directly to consumers. She says demand for the tomatoes is "not too bad".

"It is a very significant milestone for CRISPR foods," says Nigel Halford at Rothamsted Research in the UK.

Earlier this year, Sanatech Seed also gave away seedlings to anyone who wanted to grow the gene-edited tomatoes in Japan. Around 4200 gardeners took up the offer, says Sumiyoshi.

As far as *New Scientist* has been able to establish, the tomato is the first food altered with CRISPR to be launched commercially anywhere in the world. Consumers in the US are already eating gene-edited soya bean oil, but it was created using an older method of gene editing.

"Looking at the media,

These genetically engineered tomatoes are available in Japan

it seems like our tomato is the first CRISPR/Cas9 product, but we don't know if it really is," says Sumiyoshi.

"As far as I know [it is the first]," says Jon Entine at the Genetic Literacy Project, a US-based non-profit organisation. "Corteva's CRISPR corn has gotten clearance in Canada, but I've not heard that it's yet released."

4200

Number of gardeners given gene-edited tomato seedlings

A non-bruising mushroom created by CRISPR was approved in the US in 2016, says Halford. "However, I do not know if it went on sale."

The Sicilian Rouge High GABA tomato produces less of an enzyme that breaks down the amino acid GABA, or gamma-aminobutyric acid, resulting in the tomatoes containing five times as much GABA as normal tomatoes. GABA is produced in our bodies and plays a key role in the brain and nervous system. It is also sold as a dietary supplement. The benefits of eating extra GABA are debated, but a review of the evidence last year concluded that "GABA intake may have beneficial

effects on stress and sleep" (*Frontiers in Neuroscience*, doi.org/gxhn).

Gene editing involves changing an organism's existing DNA, whereas earlier forms of genetic engineering usually involved adding extra bits of DNA from other organisms. Because many changes introduced by gene editing also occur naturally, in some countries foods produced using this method aren't subject to the same rules as other genetically modified crops.

In December 2020, regulatory authorities in Japan decided not to regulate Sicilian Rouge High GABA as genetically modified, paving the way for its launch. Sanatech Seed is also considering launching the tomato in other countries. The US Department of Agriculture has already confirmed that Sicilian Rouge High GABA won't be regulated in the same way as conventional genetically modified crops.

In the UK and European Union, the tomato would currently be regulated as genetically modified, making it prohibitively expensive to get approval. However, the UK is expected to alter its laws soon. Sanatech Seed has previously said it is "keeping a close eye" on regulations in the UK.

Many other CRISPR products are being developed. Japanese authorities are currently assessing a red sea bream that has had its genome edited to produce up to 50 per cent more muscle. According to the *Yomiuri Shimbun* newspaper, the gene-edited fish could be approved this month.

Field trials of a CRISPR wheat created by Halford's team have begun in the UK. Bread made from this wheat will have lower levels of the cancer-causing substance acrylamide. ■



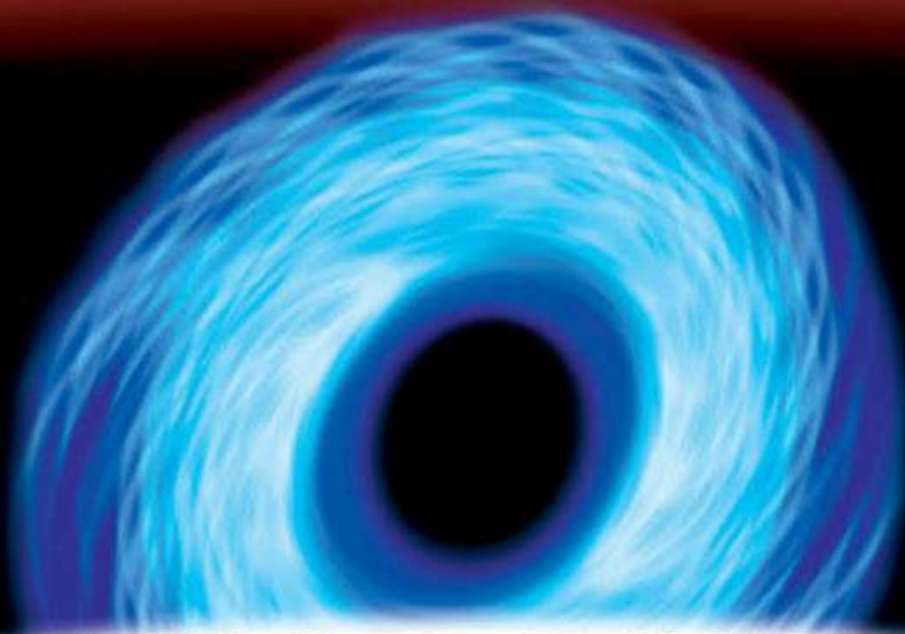
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COP26 is for ordinary people

Efforts to tackle climate change aren't just the concern of environmentalists any more, COP26 president Alok Sharma tells **Adam Vaughan**

THE man charged with leading a successful climate change summit in five weeks' time insists he is no environmentalist – but is now convinced of the urgency of tackling global warming.

"I'm a normal person, right, I'm not someone who's some great climate warrior coming into this," says Alok Sharma, the president of the COP26 meeting, who took up the job in February 2020. "But it has given me a real appreciation and understanding of why it is so vital that we get this right."

Sharma says this understanding is also spreading, citing a recent chat with a nurse performing a

\$100bn

Annual climate finance funds promised by rich nations

routine covid-19 test. "She said: 'Thank you for what you said about taking care of the climate yesterday on the news'. This is resonating with ordinary people like me, who weren't focused on this necessarily. We have to get this right, for our generation and future generations."

It is an attitude shared by his boss, UK prime minister Boris Johnson. "I am not one of those environmentalists who takes a moral pleasure in excoriating humanity for its excess," Johnson told the UN General Assembly in a speech on 22 September, where he called the COP26 summit in Glasgow, UK, this November a "turning point" for humanity.

COP26 is seen as the most important climate meeting since 2015, when the world adopted the Paris Agreement to hold global warming to below 1.5°C

The aftermath of Hurricane Irma on Barbuda in 2017

at best and well below 2°C at worst.

A hundred world leaders have said they will attend the summit, making it the largest political gathering the UK has ever hosted. Sharma says that number will grow, although key players such as Chinese president Xi Jinping haven't yet confirmed whether they will attend. US president Joe Biden has said he will be there, along with high profile figures including Pope Francis.

Sharma says he had very constructive but frank discussions with China's top climate diplomat, Xie Zhenhua, when he visited China last month. "I said it's good to get these commitments from the president, what we now need to see is the detailed policy. I hope some of that may come forward before COP – the ball is very much in China's court."

Sharma also insists the summit can keep the 1.5°C target in reach, despite a recent UN report showing that global emissions are expected to rise by 2030 rather than almost halving as required to meet the temperature goal.

"I think keeping 1.5°C alive has to absolutely be the aim," he says. "[But] the UN report was pretty sobering." It did contain bright spots though, he says: some



Alok Sharma is the president of the COP26 climate meeting

countries are on track to cut their emissions by more than a tenth by 2030 and many of the biggest polluters have yet to set out a revised emissions reduction plan, leaving the door open for further action before COP26.

"If all the biggest emitters were to follow suit, we would make a big dent on where we need to be by the end of this decade," he says. G20 countries delivering on the promise of more ambitious plans will be key, he adds. Several, India included, have yet to submit one.

While Sharma won't be drawn on which countries Johnson will visit in the final weeks before

COP26, he says the prime minister is keen to make it a success: "What I can tell you is he's been invested in this process in the calls he's had bilaterally with world leaders."

Sharma also wants to see rich nations deliver on a promise, made 12 years ago, to give \$100 billion a year of climate finance to poorer ones by 2020. In 2019, these funds were still \$20 billion short, but they are growing. Last week, President Biden announced a doubling of US climate finance, to \$11.4 billion a year, a step Sharma says provides a big boost.

"This \$100 billion figure has become absolutely a matter of trust in politics, but particularly in climate politics. Trust is pretty fragile. We need to rebuild this trust if we're going to get everyone on the same page," says Sharma.

He has travelled to dozens of countries in the past year to build support for the climate summit. Sharma said a visit in July to the Caribbean island of Barbuda, where he witnessed the destruction left by Hurricane Irma in 2017, was one of the most moving experiences.

"The place is still devastated, literally it felt like a hurricane came in a few weeks ago. It's been really very, very challenging for them. You've seen migration take place. This is one of the challenges with climate change: as things get worse, migration is going to become a real issue," he says. The Intergovernmental Panel on Climate Change projects that migration will grow this century because of the changing climate.

Sharma says a representative of another small island state has told him that climate change meant they soon wouldn't have a place to call home. "It is as stark as that for millions and millions of people around the world," he says. ■



SALWAN GEORGES/THE WASHINGTON POST VIA GETTY IMAGES

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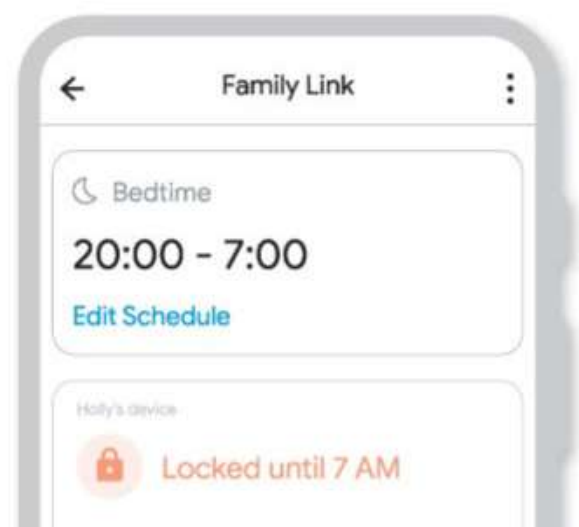


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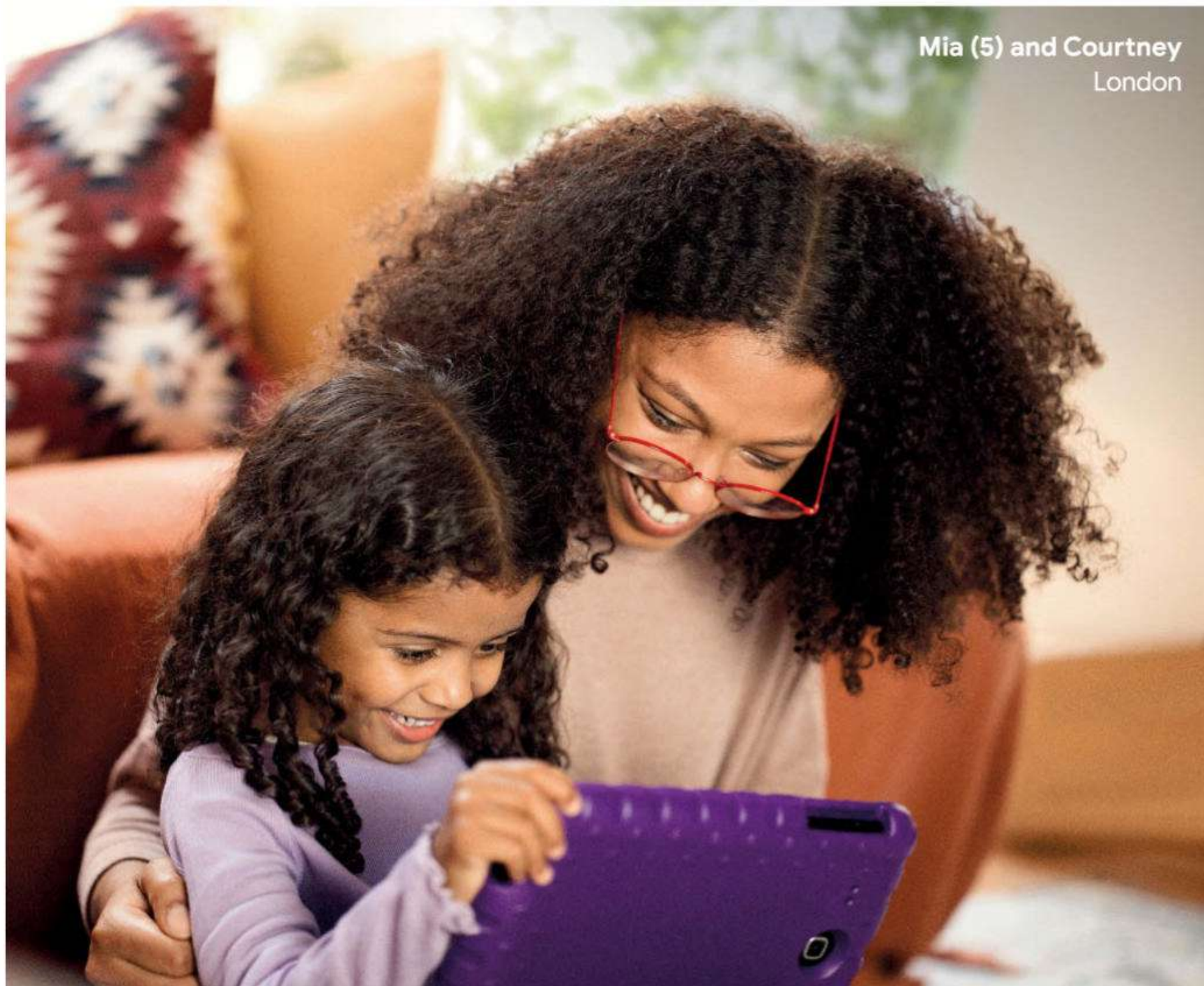


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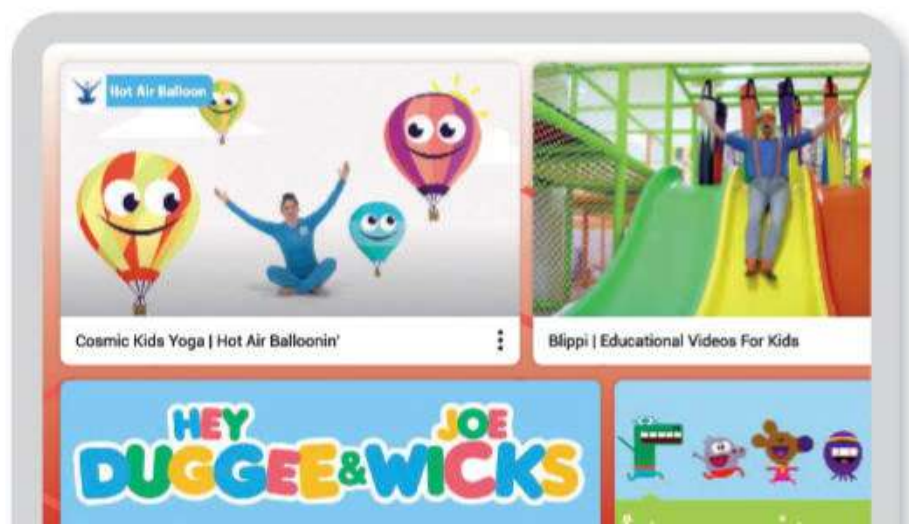
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Military technology

US Air Force has started using AI to choose targets to strike

David Hambling

THE US military has begun to use AI to guide its air strikes, according to Secretary of the Air Force Frank Kendall. Speaking at the Air Force Association's Air, Space & Cyber Conference in National Harbor, Maryland, on 20 September, Kendall said that the US Air Force (USAF) had recently "deployed AI algorithms for the first time to a live operational kill chain".

Kendall said this use represented "moving from experimentation to real military capability", but didn't give details of the strike, such as whether it was by a drone or piloted aircraft, or if there were civilian casualties.

The kill chain is the process of gathering intelligence, analysing it and directing weapons to destroy a target. The AI was incorporated into the Air Force Distributed Common Ground System (DCGS), which combines data from various sources, including MQ-9 Reaper drones. DCGS collects and analyses more than 1200 hours of video per day and the USAF is seeking to automate parts of this laborious process, for example with



U.S. DEPARTMENT OF DEFENSE ARCHIVE/ALAMY

A US MQ-9 Reaper military drone on the ground

automated target recognition.

Human analysts can also make deadly mistakes. In one recent case, a car in Kabul, Afghanistan, supposedly full of explosives was targeted. It was actually loaded with water, and the resulting drone strike killed 10 innocent people, including seven children.

With the recent withdrawal of US troops from Afghanistan, President Joe Biden announced

the US will rely on more "over-the-horizon" operations in which strikes are carried out without forces on the ground to confirm targets. While the new AI can't order a strike, the fact that it is identifying possible targets for human approval represents a significant inroad into the decision-making process, and the lack of details on the system makes it difficult for experts to evaluate. The USAF told *New Scientist* it wouldn't be able to comment before publication.

"Originally, automated target

recognition was about identifying and tracking well-defined military targets," says Jack McDonald at King's College London. "We don't know what kinds of objects or patterns of activity these systems are now trying to recognise."

Arthur Holland at the United Nations Institute for Disarmament Research in Geneva, Switzerland, says that although expected, use of AI for targeting raises serious policy questions.

"How does one test such algorithms and validate that they are reliable enough to be used in life-or-death missions?" he asks. "How can operators know when to trust the AI system and when to override it? If an erroneous strike is launched in part on the basis of an erroneous AI system's output, does that affect the balance of human responsibility and accountability?"

McDonald says that the technology eventually becoming accessible more widely, as has happened with drones, is also a concern. "I'm much more worried about if or when this sort of technology gets in the hands of militias and non-state actors." ■

Marine biology

Antarctic seal numbers rose and fell with climate

THE Antarctic fur seal population has grown and shrunk over the past 50,000 years as the climate has changed, a genetic analysis suggests – and the finding could help us predict where the marine predators will live in the future.

Today, Antarctic fur seals (*Arctocephalus gazella*) appear loyal to the same islands. During the annual breeding season, some return to within a few metres of the

same spot on the shore each year.

Alison Cleary at the British Antarctic Survey examined the fur seals' history while at the University of Agder in Norway. With her colleagues, she sequenced DNA samples from four populations on South Georgia, Bouvet Island and the South Shetland Islands in the south Atlantic Ocean and on the Kerguelen Islands in the southern Indian Ocean.

They then used software that analyses genetic data and estimates how an animal species' population size has changed through time, and when two or more distinct

populations today were last part of a single, larger population.

They found that despite seals' tendency not to move to new areas, populations have grown and fallen through time. For example, before the last glacial maximum, which occurred 26,000 to 13,300 years ago, the seals seemed to exist as one global genetic population in which any two animals could interbreed. But then, seal numbers

"Populations decline when the ice increases, then you see them moving to new colonies as it decreases"

shrank and the population in the southern Indian Ocean became genetically isolated and distinct from the others (*Ecology and Evolution*, doi.org/gxgk).

"You see that the populations decline when the ice increases, then you see them moving out to new colonies as the ice decreases again," says Cleary.

She says that tracking the way Antarctic fur seal populations have moved in the past could help conservationists predict where they might move under future climate scenarios, and help protect them. ■
Joshua Rapp Learn

Solar system

Speeding probe could grab signs of life on Enceladus

Jonathan O'Callaghan

WE SHOULD be able to detect signs of life like amino acids on Saturn's moon Enceladus without destroying them in a high-speed collision.

In 2005, NASA's Cassini spacecraft found evidence that plumes of water ice were erupting from Enceladus, with images showing clear evidence they were coming from the moon's south pole region. Later studies suggested these plumes originated from a subsurface ocean, located beneath an icy shell, which could host conditions right for life.

Cassini itself wasn't able to look for life in the plumes, lacking the necessary instruments, so Richard Mathies at the University of California, Berkeley, and his team performed experiments to see if a future mission might be able to do so. By firing ice particles into metal foil with a gas gun at speeds of up to several kilometres per second, the team simulated how a spacecraft flying through the plumes might be able to capture material.

Their experiments showed that even at speeds of up to 3 kilometres per second, a spacecraft could capture sufficient material to be studied on board to look for evidence of life, such as amino acids or sugars. "The organic molecules survive the impact," says Mathies.

A craft orbiting Saturn would be able to travel at speeds of less than 3 kilometres per second as it flew past Enceladus to sample the plumes. If it orbited the moon, it would be even slower – 200 metres per second – making sample capture even more efficient (*The Planetary Science Journal*, doi.org/gxdt).

No mission to Enceladus is currently in development, however Mathies and his team hope their findings might inform the planning for one. "Enceladus presents an outstanding opportunity, because it basically presents a sample to us automatically," he says. ■

Analysis Phone chargers

European Union powers ahead with charger plan Law mandating USB-C connections on portable devices would cut e-waste, but Apple is unhappy, says Matthew Sparkes

EVERY new smartphone, tablet, camera and handheld games console sold in the European Union will have to use a standard USB-C charger, should a new proposal designed to slash e-waste become law.

The European Commission (EC) says this would make charging more convenient and reduce the environmental footprint of producing and disposing of chargers. Some 11,000 tonnes of charging equipment is ditched annually in the EU, it claims.

The law would also force manufacturers to offer new devices for sale without chargers, as the common standard would mean that most households already have them. The proposed common charger format would reduce e-waste by almost 1,000 tonnes annually across Europe, claims the EC. Laptops and other large devices won't be covered by the legislation.

Most smartphone models sold around the world already use the USB-C standard, but some companies, most notably Apple, are resisting. Apple told *New Scientist* that it is "concerned that strict regulation mandating just one type of connector stifles innovation rather than encouraging it, which in turn will harm consumers in Europe and around the world".

Apple has a long history of sidestepping industry standards and developing proprietary connectors. When the first iPhone launched in 2007, it was equipped with a 30-pin connector designed by Apple. Other smartphones at the time used Micro USB or other proprietary connectors.

This 30-pin connector was replaced in 2012 with another Apple invention, the Lightning port, which had a symmetrical form,

allowing cables to be plugged in both ways up, unlike previous USB cables that have to be inserted the correct way. USB-C appeared two years later, also with this feature.

Future EU legislation could allow new standards to be adopted, although there is no automatic provision for that in the proposed regulations. In any case, any potential pace of change would almost certainly be slower than if technology companies were free to change whenever advantages were possible.

The EC has suggested that companies would have two years to make the switch to USB-C, but Apple says it is concerned this is too fast despite its rapid replacement of models almost every year. It argues that older versions of its phones tend to remain on sale as cheaper alternatives for customers, sometimes for several years.

Any change would probably be made to models sold around the globe, rather than manufacturing a different version for Europe.

In 2009, the EC considered similar proposals mandating

Micro USB ports as standard on all mobile phones, but this was ultimately watered down to a voluntary agreement signed by manufacturers. That was successful in reducing around 30 proprietary connectors on the market to just three: USB-C, Micro USB and Lightning. However, that is where progress halted.

Apple signed the 2009 voluntary agreement at the time, along with Nokia, RIM (now known

11,000
Tonnes of EU e-waste from old or unused chargers per year

as BlackBerry) and others, but held out for another two years before complying. Its solution met the wording of the deal, but perhaps not the spirit, by offering customers the option to buy a separate Micro USB to 30-pin adaptor and continuing to ship phones with its own proprietary connector.

Margrethe Vestager, who oversees IT and telecoms policy at the EU, said in a statement this week that industry had been given "plenty of time to come up with their own solutions", but that now legislation was needed.

Although the proposals from the EU wouldn't necessarily be binding in the UK post-Brexit, there is at least some support for the idea from UK politicians. Philip Dunne, chair of the UK parliament's Environmental Audit Committee, says: "There are 140 million discarded and unused cables in UK homes, enough to circle the Earth five times. To reduce the wasteful production of new cables, manufacturers should coalesce around a common standard, enabling us to re-use existing cables when replacing our electronic devices." ■

USB-C cables (left) and Lightning cables (right) are used for charging



NIKKIMEEL/ALAMY

Space

Window for life on Venus narrows to first billion years after it formed

Jason Arunn Murugesu

VENUS may have been habitable for close to a billion years – far less time than previously thought, but still long enough for life to evolve.

The planet's atmosphere is mainly made up of carbon dioxide and its surface is too hot for liquid water. Dennis Höning at VU Amsterdam in the Netherlands and his colleagues modelled how Venus may have developed its atmosphere.

Previous research has indicated that it could have been habitable for 2 to 3 billion years, but didn't account for the planet's lack of plate tectonics. "We've never seen evidence of plate tectonics on Venus," says Höning. The new calculations including this detail suggest this viable period was during Venus's first 900 million years. That is still long enough for life to evolve – though it probably isn't sufficient time for complex life to develop in the way it did on Earth, says Höning.

Key to this model is that when Venus was born 4.5 billion years ago, the sun would have been a lot dimmer. As such, it would have been easier to maintain

liquid water on the planet's surface, says Höning.

Using their model, he and his team found that any such water would have reacted with the CO₂ released into the atmosphere by volcanic eruptions. This would have produced carbonic acid, which would have dissolved silicate rock, helping to capture CO₂ in rocks as carbonates. Unlike on Earth, which has plate tectonics,

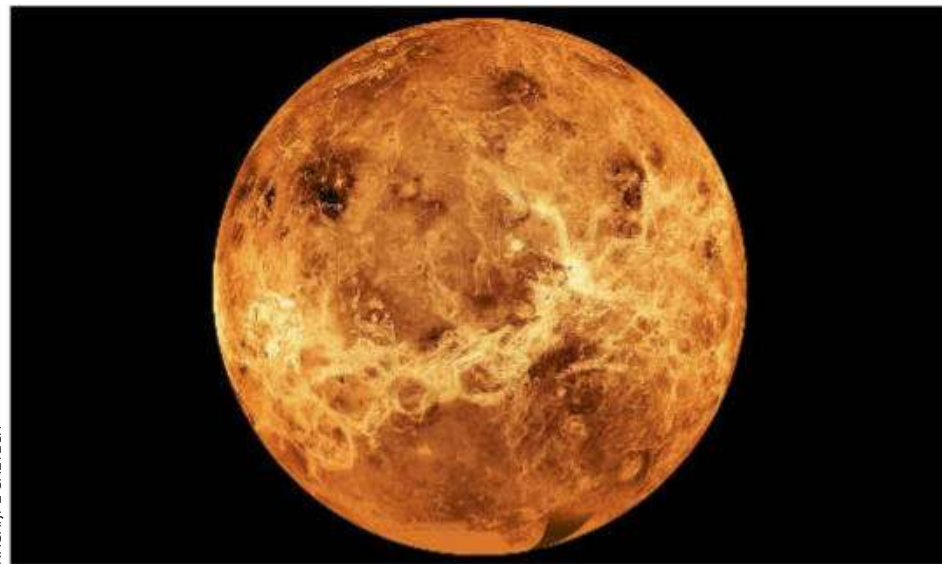
Venus has no signs of plate tectonics beneath its thick atmosphere

these carbonates wouldn't have been recycled back into the planet's mantle and would have instead continued to build up.

The hotter these carbonates got as they were buried deeper by successive volcanic flows, the more unstable they would have become, releasing CO₂ through the cracks in the surface. This would have set off a strong greenhouse effect, leading even more of Venus's rocks to release CO₂ and resulting in the environment we see on Venus today (arxiv.org/abs/2109.08756).

"Nine hundred million years is less than a third of some of the more optimistic estimates for how long Venus may have been habitable," says Richard Ghail at Royal Holloway, University of London. He says this is important because there are three missions to Venus in the works that will map the planet's surface and analyse its atmosphere to determine whether Venus really did once have water. "The longer it was [habitable], the better the chances that these missions will find evidence of those past wet environments."

But Helmut Lammer at the Austrian Academy of Sciences in Graz says he is still sceptical that Venus was ever habitable. "The atmosphere on Earth for the first billion years wasn't stable due to extreme UV radiation from the sun," he says. He argues that shortly after it formed, Venus would have received more than double the UV radiation that Earth did, forcing the atmosphere to expand and eventually dissipate, making it less likely that the team's model is accurate. ■



NASA/JPL-CALTECH

Neuroscience

Books in childhood home provide brain boost in later life

CHILDREN who grow up in homes filled with books tend to have less cognitive decline when they reach old age, even when taking factors such as wealth into account. The finding suggests that early cognitive enrichment has long-lasting protective effects on the brain.

Ella Cohn-Schwartz at Ben-Gurion University of the Negev in Israel and her colleagues analysed data from more than 8000 men

and women aged 65 and older without Alzheimer's disease in 16 European countries, who had taken memory tests in 2011 and 2013 as part of the Survey of Health, Ageing and Retirement in Europe.

Participants were asked to recall roughly how many books their family homes contained when they were children: none, a shelf (about 25 books), one bookcase (about 100 books), two bookcases or more.

Those who grew up with larger book collections performed better in the tests. They also showed slower cognitive decline, with a smaller dip in their test scores between 2011

and 2013 (*Dementia and Geriatric Cognitive Disorders*, doi.org/gxftp).

This may be because their early book exposure encouraged them to read more, which in turn boosted their "cognitive reserve", says Cohn-Schwartz. Intellectually stimulating activities like reading are known to create extra connections in the brain that buffer it against degenerative processes like those seen in Alzheimer's disease.

"Intellectually stimulating activities like reading are known to create extra connections in the brain"

"It's highly likely they built that buffer in the early stages of their childhood that has lasted them the distance," says Ralph Martins at Edith Cowan University in Perth, Australia.

The findings persisted when the team used statistical techniques to adjust for the participants' wealth, education, physical health and other factors. This suggests that large home libraries aren't just a marker of having more money, which could protect the brain in a variety of ways, such as through better nutrition, says Cohn-Schwartz. ■

Alice Klein

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Genetics

How our ape ancestors lost their tails

Michael Le Page

AROUND 25 million years ago, our ancestors lost their tails. Now geneticists may have found the exact mutation that prevents apes like us growing tails – and if they are right, this loss happened suddenly rather than tails gradually shrinking.

“You lose the tail in one fell swoop,” says Itai Yanai at NYU Langone Health in New York.

His colleague Bo Xia says he used to wonder why people didn’t have tails like other animals. “This question was in my head when I was a little kid,” he says. “I was asking, ‘Where is my tail?’”

1 million

Number of *Alu* genetic parasites in the human genome

More recently, Xia injured his coccyx – a bit of bone at the base of the spine that is a vestige of mammalian tails – in a car accident. “It was really painful,” he says. “It kept reminding me about the tail part of our body.”

Any mutations involved in tail loss should be present in apes, but not monkeys. Xia and his colleagues compared ape and monkey versions of 31 genes involved in tail development.

They found nothing in the protein-coding regions, so they looked in the bits of junk DNA found inside genes. If you think of proteins as flat-pack furniture, the genetic instruction booklets for making them come with lots of pages of gibberish that must be removed before the instructions work. These extra bits, called introns, are cut from the mRNA copies of genes before proteins are made.

What Xia found is that in the ancestor of apes, in a tail gene called *TBXT*, an *Alu* element

landed smack bang in the middle of an intron. *Alu* elements are genetic “parasites” that copy and paste themselves all over the genome. “We have 1 million *Alu* elements littering our genome,” says Yanai.

Normally, an *Alu* in an intron would make no difference – it would get edited out with the intron. But in this case, there is another *Alu* element nearby, but it is in reverse order. Because the two sequences complement one another, they bind together, forming a loop in the mRNA.

That effectively glues several pages of instruction booklet together, meaning that when extra pages are cut out, some of the instructions are often lost too. This means the assembled furniture – the *TBXT* protein – often has a key piece missing.

The researchers did experiments to demonstrate this. For instance, they showed that mice with this mutation produce a mixture of full-length and missing-bit *TBXT* proteins,

Fossils suggest the first tailless apes walked on all fours

like apes do, and that this usually results in complete tail loss (bioRxiv, doi.org/gw3t).

“It may tell us why all of a sudden when we see the apes [emerge] they have no tails,” says Carol Ward at the University of Missouri. There is no evidence of a slow reduction in tail length in the fossil record, says Ward, but for now we have too few fossils to rule it out.

What the finding cannot tell us is why evolution selected for this mutation. Most proposed explanations involve tails being a disadvantage when early apes started moving in a different way, such as walking upright on branches. But fossils suggest that the first tailless apes still walked on all fours, says Ward.

Xia and Yanai think there must have been a strong advantage to losing tails because this mutation does also have a disadvantage. Some mice developed spinal abnormalities resembling spina bifida. They speculate that the relatively high rate of spina bifida in people is a lingering relic of the loss of our tails all those millions of years ago. ■



SHUTTERSTOCK/ALEXWILKO

Technology

US army to 3D print concrete bridges in disaster areas

David Hambling

THE US Army Corps of Engineers can now print concrete barracks, bunkers and other structures in challenging environments. Its Automated Construction of Expeditionary Structures (ACES) programme has also drawn up plans to create the world’s first 3D-printed vehicle bridge, and prototype printers should be in the field next year.

“Our priority was to develop a capability utilising 3D printing technology for use in an expeditionary environment, specifically suited for military purposes,” says Megan Kreiger, programme manager for additive construction at the US Army’s Engineer Research and Development Center in Vicksburg, Mississippi.

“That means it has to ship in a container, it has to use local materials, it has to work in a dirty environment and it needs to be able to take a beating while still remaining reliable,” she says.

Commercial printers for concrete-like materials lack this robustness, says Kreiger. For instance, they typically require special mortar. The ACES technology can 3D print concrete made with locally sourced aggregate.

According to the US Army Corps of Engineers, some ACES technology can build a sample structure in one day rather than five, with a crew of three rather than eight. “You can create complex shapes very easily at little to no added cost,” says Kreiger.

She notes that the benefits of using the ACES technology will be most helpful in remote areas. This includes disaster relief situations where housing, bridges and other structures are needed fast.

Kreiger’s team now plans further demonstrations, including the first ever 3D-printed vehicle bridge. ■

Hints of a solar system smash-up

Jupiter's wobbles may have flung asteroids together to make hybrid meteorites

Jonathan O'Callaghan

A METEORITE that fell on Earth more than a century ago may contain some of the first concrete evidence for a cosmic mash-up in the early solar system.

Following the birth of our sun 4.5 billion years ago, it is thought that Jupiter's formation caused two reservoirs of asteroids to gather in the solar system, one inside the giant planet's orbit and one outside. The former are known as non-carbonaceous asteroids, because they are traditionally low in carbon, whereas the latter are carbonaceous asteroids, richer in things such as water and carbon that were able to survive further from the sun's heat.

There had been some evidence that dust from these two reservoirs had mixed, possibly as a result of Jupiter and the other outer planets migrating slightly in their orbits towards and away from the sun as the solar system settled.

Now, Fridolin Spitzer at the University of Münster in Germany and his colleagues have found some of the best evidence yet

for mixing. It comes from a meteorite that appears to contain both carbonaceous and non-carbonaceous material. "This implies it's a mixture between these two reservoirs," says Spitzer.

The space rock, called the Nedagolla meteorite, fell in India in 1870. It was already unusual in that its chemical composition didn't match any other meteorites analysed to date, suggesting it didn't share a common origin with any meteorites on Earth.

When Spitzer and his team studied the meteorite to learn more about its origins, they were surprised to find pockets of the element molybdenum with different concentrations, some corresponding to carbonaceous meteorites and others to non-carbonaceous ones.

Measurements of the radioactive decay of the meteorite suggest that it formed at least 7 million years after the birth of our solar system (arxiv.org/abs/2109.04224). Two asteroids from the inner and outer reservoirs appear to have smashed together to form the meteorite,



VICTORIA RUBAN/ALAMY

Jupiter's formation separated asteroids into two groups

possibly as a result of Jupiter's gravitational pull as it moved towards or away from the sun.

"It's nice to find evidence that this actually happened," says Spitzer. If the team is correct, it would be some of the first meteoritic evidence that the mixing really took place.

"It's exciting," says Harold Connolly at Rowan University in New Jersey. "It's what we should

be able to see if Jupiter was migrating and throwing material in and out of the solar system."

Other indirect evidence for this migration does exist, says Sara Russell at the Natural History Museum in London, such as the small size of the planet Mars – possibly the result of Jupiter being closer to Mars than it is today and sweeping up material, preventing Mars from growing larger.

"Then there's the massive diversity of material in the asteroid belt, which is really a jumble of super-ice-rich stuff and stuff that's at [relatively] high temperature," says Russell. "You need to have something stirring the pot to mix things up."

The Nedagolla meteorite would be the first physical evidence of a collision between a pair of asteroids from the two reservoirs, though. Meteorites already in collections on Earth may also contain similar evidence.

"There's so many parts of the collections that are really unexplored," says Russell. "I'm sure there are loads and loads of secrets to find out." ■

Animal behaviour

Elephants used in Thai tourist industry have nervous tics

MORE than half the elephants in multiple Thai tourist facilities have nervous tics that may reflect anxiety, frustration or boredom.

The involvement of scientists in the elephant tourism industry has led to improvements in welfare, but many captive Thai elephants still develop repetitive behaviours called stereotypies, which are similar to nervous tics.

Pakkanut Bansiddhi at Chiang Mai University in Thailand and her colleagues observed the behaviour of 283 Indian elephants (*Elephas maximus indicus*) in 20 tourist facilities in Thailand's Chiang Mai province where elephants give tourists rides, walk side by side with them and participate in shows.

The team found that 57 per cent of these elephants showed repetitive behaviours, including swaying side to side, weaving or pacing around, bobbing their heads, making useless limb movements and rocking back and forth on their feet, at least once in a 15-minute period.

On average, the elephants did these things about six times in that period. The highest prevalence was in elephants aged between 4 and 10. Those younger than 3 and older than 50 were least likely to show these behaviours (*Applied Animal Behaviour Science*, doi.org/gxct).

"I'm surprised the figures are not higher than that," says Andrew McLean at the Human Elephant Learning Programs foundation in

"Tics in young elephants could reflect anxiety about being separated from their mothers"

Australia. "Wherever they chain elephants, there are almost always locomotor stereotypies."

Trainers generally separate young elephants from their mothers when they are 3 or 4 years old. Their tics could reflect anxiety about their new situation, says Bansiddhi. Older elephants may have simply "learned to cope better with the stress in their environment", she says.

McLean, however, wonders if older elephants have reached a state called learned helplessness, in which animals give up trying to cope. ■

Christa Lesté-Lasserre

The solace of quantum

Governments see quantum computers as something to both fear and revere when it comes to security, reports **Matthew Sparkes**

QUANTUM computers and networks, once merely physicists' playthings, are increasingly seen as both a national security threat and a potential asset, with the theoretical ability to crack current encryption methods, but also improve artificial intelligence. The recently announced security pact between the UK, the US and Australia drew a lot of attention for its focus on nuclear-powered submarines, but this AUKUS deal also promised to share quantum technologies.

It makes sense for Australia and the UK to ally themselves with a quantum tech leader like the US, not least because China, the other leader in the field, seems to be pulling ahead. In recent months, Chinese researchers have published details of the world's largest metropolitan quantum communication network and the nation's second demonstration of quantum supremacy – the ability to solve a problem that is all but impossible for regular computers.

At the heart of the security threat is quantum computers' potential use as a tool for finding the prime factors, or multiplicative building blocks, of a number – for example, the prime factors of 21 are 3 and 7. Modern encryption relies on the fact that, for large numbers, this task would take hundreds of years for even a powerful supercomputer to solve.

But in 1994, a physicist called Peter Shor came up with a theoretical quantum algorithm to find prime factors much faster – once the hardware is available to run it. Although quantum computers aren't yet powerful enough to threaten encryption, it may not be long before this changes. When that happens, secret communications around the world will be laid open.

Quantum computers could



COSTFOTO/BAROCROFT MEDIA VIA GETTY IMAGES

also radically speed up the training of the neural networks that drive most of our artificial intelligence systems, providing a boost to algorithmic surveillance.

Because of this, governments want to be the first to have advanced quantum computers for use against other states, but also want robust quantum communication networks that are immune to Shor's algorithm thanks to quantum cryptography.

The US "faces a reckoning" on this front and its technological might shouldn't be taken for granted, Elsa Kania at the Center for a New American Security, a think tank in Washington DC, told a virtual meeting on 14 September.

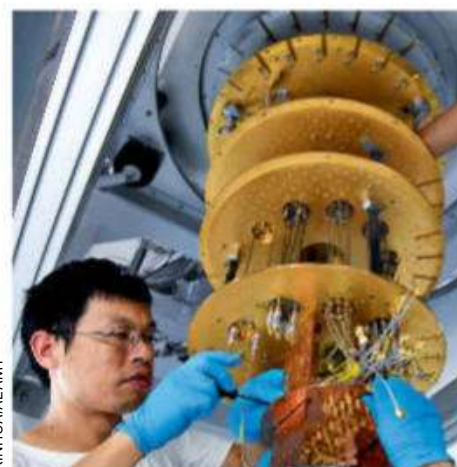
"The belief was that China still lagged behind, perhaps by years, in quantum computing and that there still was some time before we see Chinese universities or enterprises going head-to-head with the likes of Google," said Kania, referring to the US firm that made the first ever demonstration

The National Laboratory for Quantum Information Science in Hefei, China

Below: A cooling system for a quantum computer

\$625m

US government funding for quantum research in 2020



XINHUA/ALAMY

of quantum supremacy in 2019. "Instead, the gap appears to have been closer to months."

Kania pointed out that, as investment in quantum research has grown, transparency and US-China collaboration has diminished. Visas for Chinese students wishing to study in the US are harder to come by, she said, and those working on quantum projects often returned to China after studying. Meanwhile, few Western researchers are part of quantum teams in China.

Last year, the US government put \$625 million into quantum technology research, following the National Quantum Initiative Act signed by the then President Donald Trump in 2018. That is an increase on other US government funding: a leak by Edward Snowden in 2014 revealed that the US National Security Agency had spent \$80 million in 2011 trying to develop a "cryptographically useful quantum computer".

These initiatives aside, it is generally US firms rather than the state that makes quantum advances: the aforementioned Google, along with Microsoft, Amazon, HP and IBM, are all working on quantum computing, albeit using different architectural approaches, as are defence firms like Raytheon, Northrop Grumman and Lockheed Martin.

In China, meanwhile, the state takes the lead, with the publicly funded University of Science and Technology of China (USTC) in Hefei as the epicentre. A new National Laboratory for Quantum Information Science was just constructed in the city at a reported cost of \$10 billion.

In July, USTC announced it had surpassed Google's quantum supremacy efforts by solving a problem three orders of magnitude harder than that



performed by the US firm's Sycamore computer. In September, it bested its own benchmark by another three orders of magnitude.

USTC is making great strides in quantum communication too. It recently revealed that the world's largest metropolitan quantum network – involving banks, universities and government buildings across Hefei – has been running for nearly three years. In 2016, the university put the world's first quantum satellite into orbit, which it used to demonstrate that it was possible to conduct secure communications with ground stations on Earth.

Peter Knight at Imperial College London says USTC is well funded over a long time frame, which is key to success. "None of this would work without having the confidence that you've got sustained funding over a longer period to have a go at things at scale," he says.

Winning the race

So is China ahead in the quantum race? Scott Aaronson at the University of Texas at Austin says that, while USTC is winning on the number of quantum bits, or qubits, in its computers (a rough measure of their power), Google is ahead on quality. So, although USTC has been publishing work showing it has developed more qubits, Google has been striving to bring its qubits closer to useful operation with improved error correction and accuracy, he says.

However, it is all to play for. The ultimate goal for groups researching qubits is to develop the transistor of the quantum computer world – the "building block that's so reliable that it just

clobbers all of the competition", says Aaronson. Who will get there first is still unclear. "There's always an element of luck," he says. "The truth is that, right now, no one really knows which of these approaches, if any, will be the right one for scaling up."

Crucially, Aaronson says that a greater diversity of approaches are being tried in the US than in China. USTC, like Google, is heavily invested in superconducting qubits. But while IBM is also working on superconductors, Microsoft is aiming to use a type of quasiparticle that some physicists aren't sure even exists.

"If all the top people were being vacuumed up into a secret quantum computing programme, we'd notice"

There are also claims that China's budget isn't what it at first seems. Chao-Yang Lu at USTC says the central government has promised \$10 billion for quantum research, but that investment has yet to arrive, so teams have been operating with money from local government. When central funding comes, it is likely to only total around \$1 billion, he claims. China's central government didn't respond to a request for comment.

"We have been pushing this, but the real money has not arrived yet," says Lu. "We've done all this work even without the national big budget. I think Google alone maybe will have more than we invest for the whole country." Google didn't respond to a request for comment, but is reported to be planning to spend billions of dollars on quantum research.

"We're not moving so fast in terms of the national project because not all scientists in China are convinced. We're still waiting

for the real money. If there's a further delay, we'll definitely be left behind," says Lu.

Whichever country first achieves large-scale quantum computing will undoubtedly have an advantage. But it may not be as dramatic as some fear, and the milestone is likely to arrive gradually rather than suddenly being revealed to the world.

"I can't prove that if some intelligence agency right now wanted to spend a trillion dollars to build a scalable quantum computer and break encryption that they couldn't do it, on a pretty fast timeline," says Aaronson, but "there'll be some warning", he says.

First, researchers need to develop even a single reliable, error-corrected qubit, which has yet to be done. Then, this work would have to be scaled up to produce millions or billions of qubits. "You might fill an entire building," says Aaronson, meaning it is unlikely this is going on behind closed doors in a quantum version of the US Manhattan Project that developed nuclear weapons, he says.

"Quantum computing is a pretty small community – we mostly all know each other – and if all the top people were being vacuumed up into some secret programme, we'd notice," says Aaronson.

In other words, although both US and Chinese teams have achieved quantum supremacy, the world is yet to see a quantum superpower – and perhaps, ultimately, there won't be one. "Quantum computing is not a race between different countries, not a race between China and the United States. It's a race between human beings and nature," says Lu. "We would like to share with other scientists in the West and we would like to be a part of the whole science community." ■

Quantum timeline

1980 Paul Benioff creates the first theoretical model of a quantum computer

1994 Peter Shor develops a theoretical quantum algorithm to factor integers that could crack encryption

1994 The US National Institute of Standards and Technology (NIST) organises a government-sponsored quantum computing conference
1999 Yasunobu Nakamura and Jaw-Shen Tsai demonstrate that a superconducting circuit can be used as a qubit, or quantum bit

2016 The University of Science and Technology of China (USTC) launches the first ever quantum communications satellite, Micius

2016 NIST starts looking at options for post-quantum encryption, in a future where quantum computers have broken existing methods

2017 USTC demonstrates the use of secure quantum communications between its Micius satellite and ground stations on Earth

2019 Google announces that it has achieved quantum supremacy with a 53-qubit processor

2020 The Micius satellite transmits a quantum encrypted message a record-breaking 1200 kilometres between two ground stations in China

2021 Google shows the first steps towards error correction in a superconducting quantum computer

2021 USTC announces it has achieved quantum supremacy with 56 qubits, then beats its own record just months later with 60 qubits

Human migration

DNA reveals how the islands of Polynesia were settled

A GENETIC study has helped shine a light on how the Polynesian islands of the central and southern Pacific – some of them thousands of kilometres apart – were populated over the past thousand years.

Alexander Ioannidis at Stanford University in California and his colleagues analysed the DNA of 430 people of Polynesian descent to map their genetic ancestry.

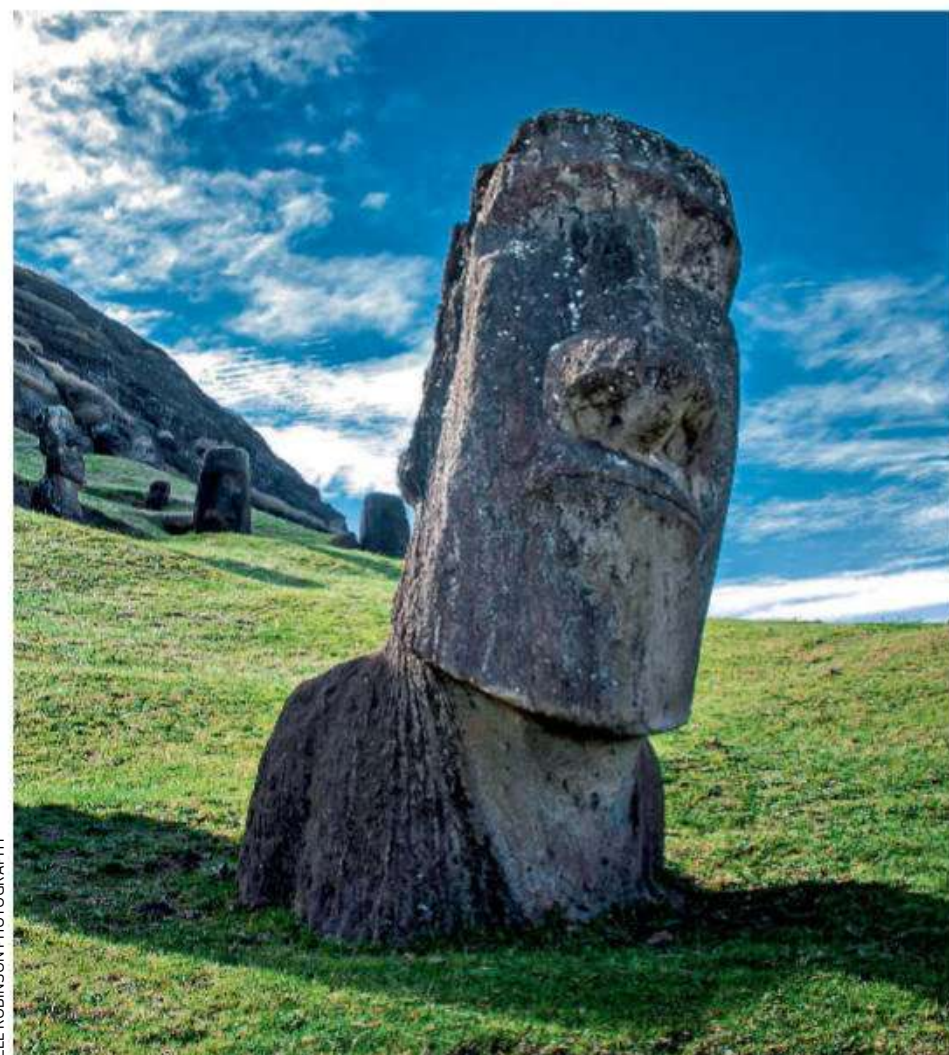
From this, they figured out the order in which the islands were discovered. They did so by using the founder effect, a genetic phenomenon in which there is reduced variation in a population if there are few initial members.

By comparing the total genetic diversity in the DNA of the study's participants across the islands, the team could tell which populations came from where first. The first

migration was from Samoa, which was settled around 3000 years ago, to the Cook Islands – a voyage of 1550 kilometres – around AD 830, according to the team.

The team then determined clearer dates for migrations by comparing specific DNA sequences in the genomes of the study's participants. If two Polynesian people on different islands have specific identical parts in their DNA, it means they share an ancestor.

The researchers found that Easter Island was probably one of the last to be populated, around AD 1100. Famous for its megalithic statues (pictured), the population is closely related to those on Marquesas and Raivavae islands – both over 3500 kilometres away – according to the analysis (*Nature*, doi.org/gw3b). **Jason Arunn Murugesu**



LEE ROBINSON PHOTOGRAPHY

Palaeontology

Dinosaurs used tails to power swagger

WHEN bipedal dinosaurs walked, they probably strode with a swagger, swishing their tails up and down for the same reason we swing our arms when we walk.

Traditionally, a dinosaur's tail has been seen as a counterbalance for the weight of its head. But John Hutchinson and Peter Bishop at the Royal Veterinary College in London say the tail probably played a more active role. With every step, the tail would swing up and down to regulate the dinosaur's angular momentum and increase its walking efficiency.

This comes from a computer simulation of *Coelophysis bauri*, a bipedal dinosaur that lived up to 220 million years ago. Hutchinson and Bishop and their colleagues designed the simulation as part of ongoing research into the locomotion of early dinosaurs.

For an accurate biomechanical

model of a long-extinct species, the team first turned to modern birds called tinamou, which are small birds that prefer running to flying. By grafting a virtual model of a tinamou's musculature onto a computerised version of its skeleton, the simulation was able to accurately replicate the tinamou's gait. The team then applied the simulation to the muscular and skeletal structure of *C. bauri*.

In this simulation, instead of statically extending backward as expected, the tail was an active participant in locomotion. With every step, it would bob up and down twice and swing left and right once, matching head and leg movements. The researchers found the rest of the dinosaur's muscles had to work 18 per cent harder to maintain a consistent running speed without the tail, suggesting that the movements made for more efficient steps (*Science Advances*, doi.org/gmwf3b). **Cameron Duke**

Security

Dab of make-up can beat face recognition

FACIAL recognition algorithms can be foiled by a bit of strategically applied make-up that is subtle enough not to look out of place.

Face-recognition software is used in smartphones and similar technology – and also by the police. Hence, there is interest in seeing how robust it is.

Nitzan Guetta at Ben-Gurion University of the Negev in Israel and her colleagues have developed

AI software that can suggest where to apply make-up to trick face-recognition systems into thinking a person's identity has changed.

Tested against real-world face-recognition technology, make-up applied according to the recommendations of the software could foil the system 98.8 per cent of the time. Across all people, the face-recognition software could identify someone successfully 47.6 per cent of the time, but this dropped to 1.2 per cent with the make-up applied.

Tested on 10 men and 10 women aged 20 to 28, the make-up cut the face recognition success rate from 42.6 per cent to 0.9 per cent in women and from 52.5 per cent to 1.5 per cent in men (arxiv.org/abs/2109.06467).

What makes the system so clever, says Mariann Hardey at Durham University, UK, is that it doesn't rely on gaudy colours, but natural hues. That means you can avoid recognition and not look out of place. **Chris Stokel-Walker**



JOCHENTACK/ALAMY



Really brief

WILLIAM WEST/AFP VIA GETTY IMAGES



Melbourne hit by its biggest ever quake

A magnitude-5.9 earthquake rocked Melbourne in Victoria, Australia, on 22 September. It was the largest on record in the area, which is far from tectonic plate margins where quakes are common. Buildings were damaged, but no one was seriously hurt. The event's epicentre was in a remote spot.

Birds made most of lockdown peace

Dozens of bird species became more abundant in urban centres in North America under lockdown because of the pandemic. The conclusion comes from an analysis of data from birdwatchers, with the change possibly explained by reduced traffic noise and air pollution (*Science Advances*, doi.org/gw29).

Tropical storms to affect billions more

If global warming reaches 3.1°C above pre-industrial levels by the end of this century, an additional 1.8 billion people will experience a tropical storm who wouldn't have if warming can be limited to 1.5°C, an analysis suggests (*Nature Climate Change*, DOI: [10.1038/s41558-021-01157-9](https://doi.org/10.1038/s41558-021-01157-9)).

Health

Parasite can evade rapid malaria tests

CHEAP rapid tests for malaria have helped cut the prevalence of the disease in many parts of Africa. But just 15 years or so after their introduction, "stealthy" malaria parasites have evolved that can no longer be detected by the tests.

In many African countries, only people whose rapid test results are positive get treated. But in Eritrea around 2016, medics noticed that many children who appeared to be really sick with malaria tested

negative. When they looked at blood samples with a microscope, they could see many of the children were indeed infected.

Jane Cunningham at the World Health Organization Global Malaria Programme in Switzerland and her team investigated and found that up to 80 per cent of malaria parasites in the area have mutations that mean they no longer make the proteins – pfrp2 and pfrp3 – detected by the rapid tests (*Nature Microbiology*, DOI: [10.1038/s41564-021-00962-4](https://doi.org/10.1038/s41564-021-00962-4)).

"Continued use of these rapid tests is selecting for [mutants] to

proliferate," says Cunningham.

Evolution is often a trade-off, with mutations that provide an advantage in one way being a disadvantage in another. But the parasites seem to thrive without the pfrp proteins, whose function isn't known.

It is common for viruses, bacteria, parasites and cancers to evolve resistance to treatments, but evolving to evade a test is more unusual – this might be the first clear example. Some places use rapid tests to detect coronavirus, which in theory could evolve to evade them. **Michael Le Page**

Animal behaviour



AGEFO/TOSTOCK/ALAMY

Hyenas make a face when they want to play-fight

HYENAS play-fight, and they have a way to let fellow hyenas know when an attack is a game: they bob their heads and make facial expressions.

Known for particularly vicious fights and a strong dominance order in their clans, hyenas also play-fight. But these animals always make sure the message is clear that they don't intend to be aggressive, especially if the fight is uneven, says Elisabetta Palagi at the University of Pisa, Italy.

Palagi and her team gathered 38 hours of play-fighting footage among 24 wild spotted hyenas (*Crocuta crocuta*) at the Greater Makalali Private Game Reserve in Limpopo, South Africa.

Their analyses revealed that the animals consistently use subtle body language to communicate that the fight isn't serious, says Palagi.

This mostly involves a relaxed, open mouth – similar to that previously reported in dogs, bears, seals and chimpanzees when they play-fight – but also a characteristic head bobbing.

The team's analyses revealed that the more one hyena was winning over another, the more the hyenas showed the relaxed, open-mouth expression (*Current Zoology*, doi.org/gw25 and *Animal Behaviour*, doi.org/gw24).

Christa Lesté-Lasserre

Technology

Bot rolls into a tube and can move uphill

A SIMPLE tube-shaped "4D-printed robot" can roll uphill, carry a load and navigate an unpredictable landscape.

Wei Feng at Tianjin University in China and his team designed the robot, built from a rectangular sheet of 3D-printed liquid crystal elastomer. When the surface it is on is heated above 160°C, the sheet self-assembles into a tubular form. This change adds a fourth dimension to the construction process, making this what the team calls a 4D-printed robot.

The robot automatically rolls forward in one direction after it forms into a tube as contact with the hot surface induces a strain in the material. The force of this forward motion is enough to allow the robot to climb inclines of up to 20 degrees and to pull loads. It can even navigate an uneven surface.

The device has potential for tactile perception, cargo transportation and unknown surface exploration, says Ximin He at the University of California, Los Angeles. Before it can be used for more complex tasks, researchers will need to add some form of remote control to the prototype, to guide its movement (*Matter*, DOI: [10.1016/j.matt.2021.08.014](https://doi.org/10.1016/j.matt.2021.08.014)). **Krista Charles**

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The columnist

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A high-tech farm may use 250 times less water **p30**

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The TV adaptation of Isaac Asimov's *Foundation* series **p32**

Culture columnist

Sally Adee reviews a techno-horror novel set on Slack **p34**

Comment

Selling stem cells

There is a stem cell revolution on the way, but it isn't the one people are pushing, say **John E. J. Rasko** and **Carl Power**

AT THE turn of the 21st century, stem cells – the master builders of the body – took hold of our collective imagination. We began to dream of their marvellous healing powers. The era of “regenerative medicine” seemed to be dawning. Soon, we would be using stem cells to repair and replace damaged hearts, joints, spinal cords, kidneys, livers, windpipes, eyes and more. You name it, stem cells would fix it.

More than 20 years have passed and we are still waiting. Despite the great promise of stem cell research and the hard work of scientists worldwide, the dream of regenerative medicine remains just that – a dream. If this sounds surprising, perhaps it is because you have heard about stem cell clinics offering treatments directly to consumers for all kinds of conditions: AIDS, Alzheimer's, arthritis and even covid-19. However, these are unproven therapies. Rigorous clinical trials haven't generally established their effectiveness, and there are still safety concerns.

Yet business is booming for those selling unproven stem cell treatments, with a global turnover of an estimated \$2.4 billion annually. In their hands, stem cells become snake oil, and stem cell research a pseudoscience.

So far, there is only one tried-and-true stem cell therapy available: bone marrow transplantation and its variants, all of which involve the use of blood stem cells to restore



someone's blood-making capacities. Pioneered in the 1950s by researchers like Don Thomas (who won a Nobel prize for his efforts), this method has been routinely used since the 1980s to treat conditions like leukaemia. Over 1.5 million blood stem cell transplants have been performed globally, with most recipients seeing significant benefits in the length and quality of their lives.

Bone marrow transplantation is certainly a form of regenerative medicine. However, it was developed long before stem cell fever took hold. The dream of regenerative medicine hinges on stem cells working other wonders. Over the years, hundreds of

thousands of scientific articles have explored this possibility, but without much success.

The chief exception is the approved use of mesenchymal stromal cells (which some scientists regard as stem cells) to treat immune disorders like Crohn's disease and graft-versus-host disease. While this is a fertile field of research, it isn't regenerative medicine. The transplanted mesenchymal cells aren't expected to restore damaged tissues and organs, merely to release useful chemicals.

Still, there is no reason to despair. The fact that regenerative medicine hasn't yet lived up to its promise doesn't mean it never

will. As the history of medicine shows, good things take time and effort. Bone marrow transplantation is a case in point.

Make no mistake, stem cell research is thriving. It has taught us a great deal about how the body works and how to treat disease.

Especially exciting is the recent invention of “organoids”. These are cultured from stem cells and usually combine several different cell types, which spontaneously form themselves into miniature organs, such as mini-brains or hearts. Organoids provide us with a much better picture of what goes on in the body than a regular two-dimensional cell culture.

So if you want a stem cell revolution, look no further. Sure, it isn't the one that we have all been dreaming of – and that stem cell charlatans have tried to hijack. But in one respect, it is infinitely better: it is real.

Although this is a lab-based revolution, its clinical implications are huge. Stem cells are speeding up the development of new drugs across the board, making it easier to decide which ones to take to clinical trial and what side effects they are likely to have. ■



John E. J. Rasko and Carl Power are the authors of *Flesh Made New: The unnatural history and broken promise of stem cells*

This changes everything

A chart lays history bare Many US universities were built using money from selling land obtained via dubious means, which an interactive map reveals in shocking detail, writes **Annalee Newitz**



Annalee Newitz is a science journalist and author. Their latest novel is *The Future of Another Timeline* and they are the co-host of the Hugo-nominated podcast *Our Opinions Are Correct*. You can follow them @annaleen and their website is techsploitation.com

Annalee's week

What I'm reading

Jill Lepore's *The Secret History of Wonder Woman*, a comic book originally conceived as a scientific experiment to promote feminism.

What I'm watching

Canadian cult sitcom *Letterkenny*.

What I'm working on

Cooking a perfectly puffy chapati.

This column appears monthly. Up next week: James Wong

LAST year, High Country News published an online, interactive map that helped me understand 200 years of US history in about 10 minutes. At first glance, it looks like one of those airline maps that show flight paths: blue and red lines arc over the nation, linking east to west. But when the map is fully loaded, there are so many lines that they blur into a cocoon swaddling the skies over North America. This isn't a map of connection after all, it is a chronicle of property theft, done in the name of education.

Anyone familiar with the university system in the US has heard of "land grant" colleges. My own alma mater, the University of California, Berkeley, is a land grant institution, as is the world-famous Massachusetts Institute of Technology, along with more than 50 others. But this interactive map, created by a team including data journalist Tristan Ahtone and University of Cambridge historian Robert Lee, reveals the truth behind that phrase "land grant".

You can zoom in to see a state, or even a neighbourhood in a city, and discover that those red and blue lines connect land grant schools to thousands of parcels of land that formerly belonged to Indigenous peoples. Each parcel was sold by US state governments in the 19th century to fund those land grant schools. It was a well-organised and well-documented heist. And now you can see it in shockingly granular detail.

During the civil war, President Abraham Lincoln signed the first of two Morrill Acts, which distributed roughly 45,000 square kilometres of federal land to the states – sometimes it was land within the state, and sometimes it was in distant western territories. The states, in turn, could sell that

land to raise money for their burgeoning university systems. Except there was a catch. It was all Indigenous people's land, procured with treaties that were coercive at best and downright fraudulent at worst. Many were what the US government euphemistically called "unratified treaties". These purported to transfer the land from the control of Native American tribes or nations to the US – except tribal representatives had never signed them, and often had no idea they existed.

I didn't know these treaties existed either until I started clicking on the interactive map.

"Universities are considering giving parts of their land back to tribes, while others are offering tuition assistance"

Working with a team of designers and data experts, the authors spent two years researching archival documents from centuries ago, linking these old records to present-day university land. Ahtone and Lee named their investigation and its subsequent map *Land-Grab Universities*.

The map works partly because the interface is simple. You can zoom in on a parcel of land right next to your house and click to learn which nation or tribe owned it before the US government treated it away. The strength of this project, though, comes from its foundation: a mountain of primary sources.

Like many colonial powers, the US government didn't erase its history of land and resource dispossession. That history was just made really inaccessible. The treaty documents linked from the *Land-Grab Universities* map spent

more than a century gathering dust in leather-bound volumes at remote offices of the Bureau of Indian Affairs and at the Smithsonian national museums. Once they were digitised, however, they became visible to people across the world and could be contextualised in a powerful new way, mapped to real places.

When I first looked at the map, I clicked on the lands that affected me the most: the parcels sold by California to fund the state university system. From there, I jumped into original documents, written in curly Victorian script, that recorded unratified treaties with tribes whose land was sold without their consent. Along with the tribes' names – Pomo, Massutakaya, Sainell, Yukias and many more – I could see how much money the state raised from the sales. In most of California, the state paid nothing for the land and made hundreds of thousands of dollars. Clicking around on this map wasn't like paging through ancient history. It felt immediate, urgent and personal.

As Ahtone and Lee explained in a virtual lecture earlier this year, their work has led many university communities to reassess their land ownership. Some are considering giving parts of their land back to tribes, while others are offering tuition assistance to Indigenous students as a form of reparation. As we move deeper into the 21st century, it is worth considering how the *Land-Grab Universities* map is just one example of what happens when we combine digitised versions of primary sources with flexible web interfaces. Call it a second-generation digital archive. It changes our access to history, and then it transforms our perspective on what we need to do about our past in the present. ■

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Editor's pick

Maybe our own planet is a neural network too

11 September, p 47

From Alan Wells,

Saltdean, East Sussex, UK

I was struck by Stephon Alexander's idea of the universe being a neural network. The concept wasn't fleshed out much in the article, and having scant knowledge of astrophysics, I'm not able to see how it would work.

But perhaps there is a good example of this on our doorstep. The Gaia hypothesis sees Earth as a complex, self-regulating system involving the biosphere, including us, the air we breathe and water in liquid, solid and gaseous forms such as in water vapour, clouds, oceans, lakes, streams and ice caps. All are tightly coupled as an evolving system. The idea is that the system as a whole, called Gaia, seeks a physical and chemical environment optimal for contemporary life.

Is it not the case that we have, in Gaia, a system of such complexity and interconnectedness that it might well be able to form an intelligent neural network?

From Richard Cohen,

Austin, Texas, US

Despite what the preamble to the interview with Alexander said, growing up in the Bronx is typical training for a theoretical physicist. The Bronx High School of Science has produced eight science Nobel laureates – seven in physics and one in chemistry – the most of any secondary school in the world. The American Physical Society has dubbed it a “Historic Physics Site”.

Nature just did the field trial for ocean seeding

18 September, p 8

From Michael Hutchinson,

Pamber Heath, Hampshire, UK

Alice Klein's article shows that a large-scale experiment to capture atmospheric carbon dioxide by seeding part of an ocean with iron

to make phytoplankton grow has now, inadvertently, been carried out for us by Australian wildfires, thanks to iron-rich ash seeding the water there.

Now, why should we hesitate to use ocean iron-seeding judiciously to capture gigatonnes of CO₂ to buy us time to address climate change and phase out fossil fuels?

The Olympics show just how uneven the world is

Letters, 4 September

From Sonia Novo, Edinburgh, UK

I have to agree with fellow reader Sam Edge. It was with some dismay that I watched Great Britain, China, the US, Japan and the Russian Olympic Committee claim medal after medal in the summer Olympics in Tokyo. I even wondered whether any other countries were competing.

The games were a stark representation of the inequalities of the world, even more so than in previous years. As it stands, they aren't a way to bring the nations of the world together; they instead assert hierarchies. But then again, have they ever been anything else?

Brush for 2 minutes, twice a day? Try this instead

11 September, p 38

From Michael Zehse, London, UK

In her look at the truth behind widely publicised health targets, Amelia Tait asks who has the time to brush their teeth properly – in other words, for the recommended 2 minutes, twice a day.

As an aged member of the underclass who can't afford expensive dentistry and who doesn't fancy walking around toothless or with NHS dentures, I think taking care of one's teeth is a worthwhile investment of time.

I spend 15 minutes in the morning and again at night, mirror in hand, carefully cleaning around my mouth – tooth by tooth, quadrant by quadrant. My teeth are still structurally intact.

From Nick Burke,

Portland, Oregon, US

Regardless of how long you should brush your teeth, flossing clears more bacteria. In that regard, given the choice of only brushing or flossing, take the latter. Once proficient, it takes 30 seconds and is painless with proper technique.

Also, as far as hydration goes, observing the colour of your urine is a good indicator. Too dark, drink more water. Very clear, drink less. Search the web for a colour chart.

Car ownership may be a hard habit to kick

4 September, p 34

From David Walmsley,

Wokingham, Berkshire, UK

In your excellent article on net-zero living, there is talk of a future with fewer cars, as many of them will be shared. Really? My impression is that most car owners love their vehicles and regard them as their private space, an extension of their homes. They are reluctant to share their cars, and will not give them up until forced to do so.

Many older people (myself included) continue to own a car when it would be demonstrably cheaper to use taxis for their journeys. I don't see why this should be different with electric vehicles or any other motive power.

From Ken Jensen,

Gibsons, British Columbia, Canada

Your well-conceived feature “A day in a net-zero life” discusses heat pumps as though they only

provide warmth. You seemed to refer to air conditioning as separate tech. However, a heat pump can both heat and cool a home. We have had one for a year. It has operated well through a cool winter and a very hot summer.

Only maths not words can describe quantum realm

28 August, p 34

From Wolf Kirchmeir,

Blind River, Ontario, Canada

Much of the puzzle of quantum weirdness resolves if we notice that, for example, “collapse of the wave function” is a metaphor (and, I think, an unfortunate one – waves don't collapse, they break on shores and slap into sea walls). This means that asking what collapses when the wave function collapses is meaningless.

The only literal language for talking about quantum mechanics is mathematics. That is why attempts to interpret quantum mechanics must resort to metaphor.

We talk about electrons as both “waves” and “particles”, when all we actually have are observations that are best described using the mathematics of waves and/or particles. Both these terms arose in classical physics. Applying them to quantum mechanics is obviously, I think, mere metaphor.

I came to this conclusion primarily because pretty much all the refutations of quantum mechanics (and relativity and so on) take these metaphors literally.

This source of greenhouse gas is a little unsettling

11 September, p 14

From Richard Pickering,

Ludlow, Shropshire, UK

I am somewhat worried that I am contributing to climate change since I am apparently farting seven times more on a plant-based diet. Please tell me that my vegetarian lifestyle will, to some extent, offset the damage from my noxious fumes. ■



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Green greens



Photographer Alastair Philip Wiper

THIS futuristic set-up looks like something out of a sci-fi film, but is in fact a simple way to grow some greens, albeit using different tools than usual.

The impressive shot, taken by photographer Alastair Philip Wiper, shows the grow hall at Nordic Harvest, a 14-storey vertical farm on the outskirts of Copenhagen in Denmark. Instead of relying on sunlight and soil to grow its crops, Nordic Harvest employs a less conventional approach: it uses robots to seed mainly leafy vegetables, such as salad leaves and herbs, in a nutrient-rich gel substrate that dissolves in water as the plants grow.

Meanwhile, LED light (responsible for the pink hue of the grow hall) and carbon dioxide are added, with renewable energy from wind turbines powering the entire process. Pesticides aren't needed as the hall is kept free of harmful creatures, and the only water leaving the farm comes from the plants themselves.

Nordic Harvest says this means the farm consumes 250 times less water than agricultural farms and 80 times less than greenhouses. It also requires 250 times less space, according to the company.

Alternative farming could play a role in curbing some of the pressures fuelling climate change, as the increasing demand for food drives carbon emissions and deforestation. ■

Gege Li

Predict and be damned

A new adaptation of Isaac Asimov's classic books stays true to the big ideas, but sensibly nixes the 1940s sexism, says **Clare Wilson**



APPLE TV



TV
Foundation
Apple TV+

WHAT would happen if we could predict the future? Not by using some kind of magic or clairvoyance, but by applying the rules of a new branch of science.

This is the premise behind *Foundation*, a new series on Apple TV+ that is based on a set of books by US science-fiction titan Isaac Asimov, set 12,000 years in the future.

In *Foundation*, the science of prediction has become a reality with the development of a field called psychohistory. This uses the familiar tools of science – maths, equations and data collected on existing conditions – to make predictions about the most likely course of world events.

The science has its limits, of course – it cannot predict the actions of individuals, for example. But with enough starting data, it can forecast the probabilities of events

such as war, uprising and famine.

In episode one, we watch as the technology comes to fruition under its genius developer, Hari Seldon, at a particularly awkward point in time for everyone.

The entire Milky Way is united as one Empire, ruled from the planet at its galactic heart, Trantor, which appears to be the height of technological and cultural sophistication. However, just as historical empires on real-life Earth may have seemed unstoppable just before their fall, the Galactic Empire already contains the seeds of its own destruction.

The galaxy is ruled by a dissolute Emperor whose megalomania leads him to unwise decisions when dealing with rebellious planets in the Empire's outer reaches. He won't relinquish power even to death, having created a series of his own clones to govern sequentially as each body ages and dies.

Using psychohistory, Seldon can see that all this will end in the collapse of civilisation, yet the only people who believe him

are the few other mathematicians who understand his language.

Fortunately, his own science lets Seldon manipulate events in order to send settlers to a new colony – the Foundation of the title – on a barren and overlooked planet in the galaxy's furthest corner. The aim is to create a repository for knowledge and technology that will survive the coming centuries of galactic war and barbarism.

“The series explores questions like: should we insist that our political leaders are scientifically literate?”

As a committed Asimov fan, I was delighted to learn that the *Foundation* books had finally been successfully adapted for the screen, after numerous aborted attempts. In the episodes I have seen so far, the story seems to be harnessing the most interesting of his ideas without sticking too closely to the original plot.

That is probably for the best, as even when I read the books

The future is a scary place, particularly if you have seen it already

as a young teenager in the 1980s, much of his work struck me as sexist. In the first book – created largely from a collection of four short stories written in the 1940s – every major character was a man, and the one time a woman seems like she might have a role to play, she gets distracted by some sparkling high-tech jewellery. The TV series, on the other hand, simply rewrites about half the characters as women, such as Seldon's protégé, Gaal Dornick (pictured). Unlike in Asimov's worlds, they are fully rounded people, rather than merely decorative sex objects.

The series also explores questions I found myself wondering as I first read the books. Given powerful enough computers, could psychohistory be possible? Would it be a good or bad thing to know the future if the outlook is bleak? And should we insist that our political leaders are scientifically literate?

The screenwriters may originally have wanted viewers to ponder that question in relation to the real-world problem of climate change, but it has taken on a new relevance today, when covid-19 death rates hinge on our leaders' willingness to “follow the science”.

While reviewers are currently forbidden by Apple TV+ from revealing anything that happens after the second episode, what I can say is that the imaginative reworking of Asimov's ideas keeps the suspense levels consistently high, even for those who know the original plot.

I may not be a psychohistorian, but I predict that this series will be enjoyed by Asimov fans and newcomers alike. ■

No time to waste

The testimonies of young people affected by climate change are both heartbreaking and empowering, says **Ibrahim Sawal**



Book **Tomorrow Is Too late**

Grace Maddrell

The Indigo Press

"WE YOUNG people are powerful. We deserve to be heard and listened to," writes 15-year-old Grace Maddrell in her first book, about the activism and work of youth climate strikers across the globe.

Based in Somerset, UK, Grace went to her first climate strike in February 2019. It sparked her passion for the environment and she has since become an activist, fighting for both environmental justice and LGBTQ+ rights, working for Fridays for Future, the youth-led movement that started with Greta Thunberg's protests in 2018.

After she took part in the global climate justice strike in September 2019, Grace was inspired to collect the voices of other youths fighting climate change. She sent out a tweet, calling for young climate activists across the globe to tell

their stories. Within hours, she was flooded with responses. *Tomorrow Is Too Late* is a collection of essays from some of those who responded.

With contributors aged between 8 and 25 years, from places including Brazil, Uganda, Australia and Palestine, this book provides a powerful snapshot of how climate change is affecting the world today. It also shows how the younger generation is fighting back, whether by giving speeches at United Nations summits about the effects of climate change or striking to raise awareness.

Each essay is given a short introduction by Grace, providing background on the person telling their story. Some of the writers are already seeing the effects of the climate crisis at first-hand. Michael Bäcklaund, a 17-year-old from Israel, says he has seen friends die because of more frequent floods. He also says the climate crisis is often ignored to focus on political conflicts: he was told by Israel's minister of energy that it was for the younger generation to fix the climate problem.

Coming from an Indigenous background, 20-year-old Lucila Auzza from Argentina feared that

she wouldn't survive to adulthood because of a lack of drinkable water as a child. She says the media there aren't showing what the government is really doing to the rainforests and how many lives have been put at risk as a result. "Throughout 2017, 42 per cent of deforestation in the country took place where regulations did not allow it," she says. Auzza says that rich countries care more about their economies than the environment.

Many of the essays call for the leaders of the world to act now, rather than leaving it up to the next generation. "Enough of climate talks, what we need now is climate action," says 24-year-old Patricia Kombo from Kenya who started an initiative to get environmental education taught in schools.

"We should not have to take the hand of the adults and drag them towards the solution that will save our planet," says 19-year-old Fionnuala Braun from Canada. She says that, in her lifetime, she has experienced more frequent extreme weather conditions, and that every year more Canadians are losing their homes to forest fires.

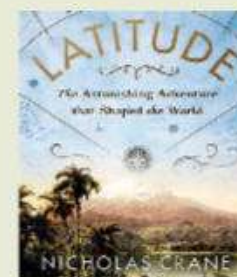
Tomorrow Is Too Late is a remarkable book that shows how educated and passionate young people can be about saving the planet. It also makes it clear that climate change is very much a global issue. Hearing the voices of children experiencing the impacts is heartbreaking, yet empowering.

The strength and determination of such people show how previous generations have failed to care for the environment. But this book is inspirational, and will ignite the inner environmentalist of those who read it. It encourages and educates people of all ages to fight for the future of our planet because tomorrow is too late. "Even a small action that you take is better than no action," says Grace. ■



Grace Maddrell wants us all, young and old, to stand up and fight for action on climate change

Don't miss



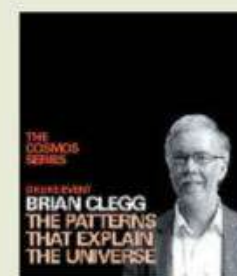
Read

Latitude is geographer Nicholas Crane's account of the first international scientific expedition, in 1735, to discover the planet's shape, a journey beset by egos, disease, mutiny and murder.



Visit

Anti-Body on 8 October at DanceEast in Ipswich, UK, sees dancers reacting to motion-responsive visuals in Alexander Whitley's latest experiment in performance and new media. A tour follows.



Watch

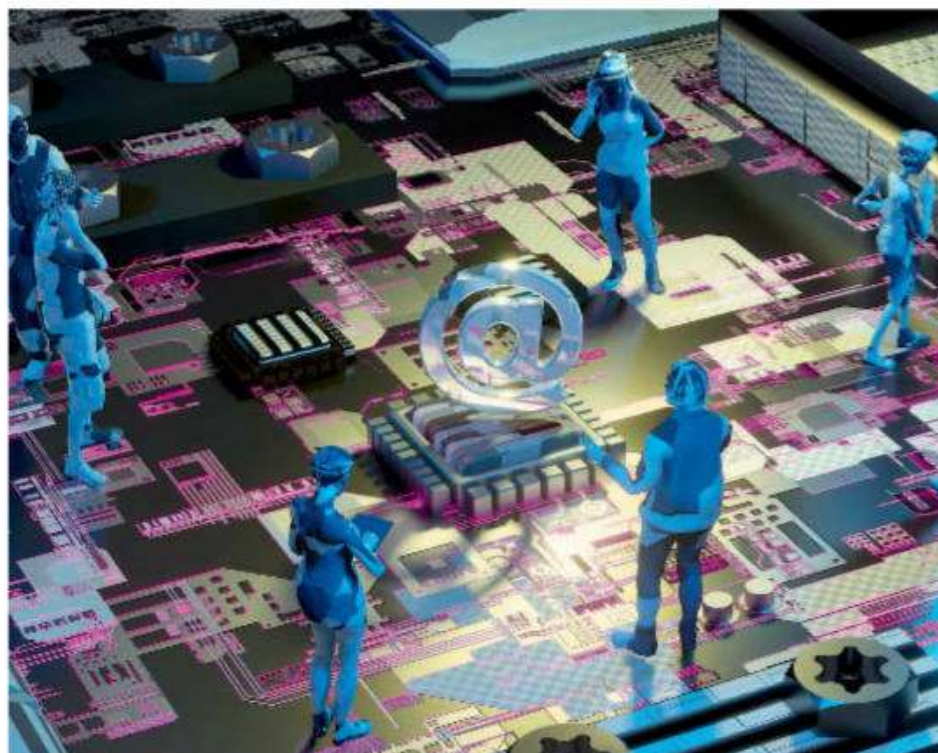
Five Patterns That Explain the Universe are explored by Brian Clegg on 7 October at 18.00 BST. This New Scientist event unpacks the shapes, from Feynman diagrams to the DNA double helix, on which reality depends.

The sci-fi column

Death by Slackbot If you ever fear being sucked into an online world against your will, this horror comedy will feel eerily familiar. *Several People Are Typing* is a Lovecraftian nightmare for the modern age, says **Sally Adee**



Sally Adee is a technology and science writer based in London. Follow her on Twitter @sally_adee



AI SLANI 3/GETTY IMAGES

Escaping the clutches of the online world is a race against time for Gerald

When he was writing the book in 2019, Kasulke worried that it would be old news by the time it was published. But the pandemic made online communication an even more encompassing part of workplace existence.

After the initial productivity burst that ensued, the balloon deflated – and kept deflating. Newspapers filled up with think pieces wondering if this was a fundamental shift in our relationship with work. In an article titled “What if people don’t want ‘a career’?”, technology writer Charlie Warzel complained of “how warped our conceptions of work have become. Only in a truly broken system could working the agreed upon hours be reframed as erecting a rigid, dangerous set of boundaries.”

The jury is still out on whether this trend is here to stay, but it seems as though many people are tired of the status quo of dead-end jobs, precarious gig work and exploitation.

If *Several People Are Typing* leaned all the way into its Lovecraftian premise, it might have been the kind of art that captures a defining generational moment in culture. Instead, though, a slightly ill-fitting conventional ending leaves the book feeling too tidy, trailing loose ends that you aren’t sure were meant to be left unresolved.

No matter, though – *Several People Are Typing* is so much fun. If you don’t think you would read an entire book of Slack chat transcripts, prepare to be wrong. My eyes burned late into the night – and I might never again look at the Slackbot without flinching. ■



Book
Several People Are Typing
Calvin Kasulke
Hachette UK

Sally also recommends...

Book
Secret Life
Theo Ellsworth
Drawn and Quarterly
Ellsworth’s comic brings to life Jeff VanderMeer’s short story about an office building and its oddball occupants.

Film
They Live
John Carpenter
This classic existentialist horror film, in which transdimensional aliens secretly control every aspect of human life and social reality, just gets better with age.

OUR worries about what the internet is unleashing on society frequently have a tinge of horror. Is Google stealing our memories? Are social media companies selling our data to the highest bidder? Will corporate instant-messaging apps like Slack ultimately suck your soul out of your still-living body?

That’s the premise of Calvin Kasulke’s *Several People Are Typing*, a techno-horror-comedy that begins when Gerald, a mediocre office drone, has his consciousness uploaded into the company Slack against his will. Because he is working remotely, his colleagues take his cries for help as an attempt at comedy. Worst of all, the Slackbot that initially seems to be trying to help may have more sinister motives.

Gerald’s attempts to get out of Slack before his body dies are reminiscent of H.P. Lovecraft’s classic sci-fi horror stories, but with Cthulhu – Lovecraft’s cosmic, sanity-destroying monster – reinvented for the 21st century.

Some of the most effective horror in *Several People Are Typing* derives from the mirror it holds up

to our own behaviours. As Gerald spends more time inside Slack, he is increasingly unable to resist sliding into automated Slack-speak. “I’m just a bot, though!” and other inane phrases emerge from him against his will, and slowly overwhelm his ability to express himself in his own words. Raise your hand if you can relate.

“With no need for sleep or other corporeal distractions, Gerald’s productivity goes through the roof”

Like all good horror, *Several People Are Typing* also carries an undertone of political critique. One major impediment to Gerald getting help is that his bosses are thrilled with his situation. With no need for sleep or other corporeal distractions, his productivity goes through the roof. His superiors ignore his pleas for assistance and instead fob him off with plaudits – which is a pretty good jab at corporate attempts to take over every waking hour of our lives.

13 days | 22 January 2023

In the footsteps of Alfred Wallace: cruise Indonesia

Explore the several Spice and Raja Ampat islands as Alfred Wallace did, marvelling at the biodiversity and stunning beauty. Cruising aboard a 22-berth luxury crewed schooner and visiting several sites that were important to Wallace's discoveries. We will help you find diverse species on land, in the air and at sea including several species of the Bird of Paradise, Golden Birdwing Butterflies and numerous sea creatures. Plus, local culture, primary rainforests, geology, conservation projects and relaxation of the highest order.

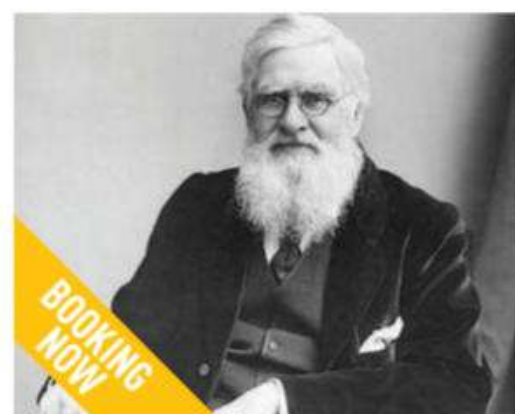
Accompanying the cruise are three experts. George Beccaloni an entomologist, evolutionary biologist and Wallace expert. Along with Nita Cesar and Kees Groeneboer, the cruise directors, who between them cover marine biology, ornithology, marine conservation charities, linguistics and Indonesian history.

Highlights

- A unique program of island exploration and evening talks.
- 12 days aboard the beautiful sailing boat Ombak Putih. A traditional Indonesian Pinisi made from ironwood that is small enough to explore the places large cruise ships can't and will mostly use its traditional sails to traverse the region, leading to a more elegant journey with lower impact on the region's ecology.
- In-depth insight into the life and work of Alfred Wallace plus the natural treasures of Indonesia.
- No more than 22 passengers on-board allowing for close and frequent interaction with the accompanying experts.

- Many opportunities to enjoy the water by kayak, paddle board and snorkelling. Discover beautiful bays, limestone cliffs and abundant coral.
- From the village of Sawinggarai on Gam Island, journey into the forest on a pre-dawn quest to spot the remarkable Red Bird of Paradise, one of the species that Wallace was most anxious to collect.
- Watch the sun rise over the picturesque chain of islands that makes up the eastern part of the Misool archipelago.
- In the mysterious jellyfish lake, swim amongst the many thousands of stingless animals, then explore more of the impressive maze of karst islands, both above and below the surface, complete with mysterious skull cairns in sea-cave cemeteries, and prehistoric cave paintings, estimated to be anything between 3,000 to 5,000 years old.
- Explore the forested slopes where Wallace made some of his greatest zoological discoveries, including the Moluccan Cuscus, the Standardwing Bird of Paradise, the world's largest bee Megachile Pluto, and the huge and magnificent Golden Birdwing Butterfly.

For every guest, we will make a contribution to the Wallace Correspondence Project, whose aims are to locate, digitise, catalogue, transcribe, interpret and publish the surviving correspondence and other manuscripts of this important 19th century scientist.



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Next-generation satellite systems, embracing innovation, critical to meet extreme weather challenges: EUMETSAT

Focus is on delivering tangible benefits to society in organisation's new strategy, "Destination 2030"

This Northern Hemisphere summer gave a grim insight into the impact of extreme weather on communities. Floods, fires and record heat cost hundreds of lives and destroyed infrastructure and livelihoods.

Providing fast, accurate information about severe weather events is an increasingly acute challenge for meteorological services around the globe in their critical role of protecting their communities.

The increasing incidence of extreme weather events resulting from climate change adds to the challenge.

Europe's meteorological satellite agency, EUMETSAT, a 30-member-state intergovernmental organisation, this month released a new, long-term strategy, "Destination 2030", which aims to help meet this challenge.

Through more advanced satellite systems and instruments coming on stream, by embracing innovation in fields such as artificial intelligence and machine learning and by exploring opportunities from the "new space" sector, EUMETSAT expects to make significant progress in the decade ahead.

"The first, and most critical, objective in the strategy is to successfully deploy our next-generation geostationary and low-Earth-orbit satellite systems," EUMETSAT Director-General Phil Evans says.

"Our existing low-Earth system is already the biggest contributor to accuracy for weather



Advertising feature

forecasts 12 hours to 10 days ahead in Europe, while our Meteosat geostationary system is critical for 'nowcasting' fast developing weather events like severe storms."

The next-generation systems will bring this to a whole new level, with new and more advanced instruments which will provide vastly more and higher-quality data more quickly.

"To give just one example, the instruments on our Meteosat Third Generation satellites will, for the first time, allow us to track the full lifecycle of storms. They will detect initial instability in the atmosphere before clouds have even formed, provide more rapid, higher-resolution observations of the development and track of storms and observe lightning strikes.

"The system will literally save lives."

The first of the Meteosat Third Generation satellites is scheduled for launch at the end of 2022 and the first satellite in the low-Earth-orbiting, EUMETSAT Polar System – Second Generation is expected to be launched at the end of 2023.

By 2030, EUMETSAT will have renewed its fleets on both orbits, Evans says.

Destination 2030 also commits EUMETSAT to continue embracing innovation and cooperation to make additional data available for weather and climate forecasting more quickly and easily.

"This includes seeking opportunities from new approaches to satellite development, including exploring the potential benefits of 'new space' innovations," Evans says.

"This will mean striking an appropriate balance between traditional and new approaches.

"We must innovate but our larger reference satellites will remain essential.

"We have to recognise that what we need is more information of quality, rather than just more information.

"There are potentially very promising avenues currently considered by new space companies, but they must be carefully assessed and their impact demonstrated.

"What is crucial is that the data we send to our member states' meteorological and hydrological services has a positive impact on weather forecasting models."

Strengthening cooperation efforts with the European Union and other space agencies is also central to Destination 2030.

"Though our involvement in the EU's Copernicus Earth observation programme, and through data and science exchange agreements with other space agencies, EUMETSAT will be well-positioned to provide global, highly accurate data about the Earth system for use in weather and climate models," Evans says.

"Our investment in the translation of data into products and services for weather and climate forecasts and in cloud technologies to make access faster and easier, will continue to pay dividends.

"To remain at the forefront in terms of data management and ease of access to data for users, EUMETSAT has adopted a cloud-based, 'big data' approach.

"Let me put this into perspective.

"At the end of 2020, there were 6pb of data in EUMETSAT's archive, which stretches back more than 40 years.

"By the end of 2025, we expect to have about 50pb of data in the archive.

"We expect that our new services will not only benefit the meteorological services in our member states but also vastly increase the variety and number of people who will use our data, including those who wish to develop various weather or climate-related applications."

The objectives in Destination 2030 will equip meteorological services in EUMETSAT's member states and others around the globe with the data they need to protect the communities they serve, Evans says.

"Our ability to flexibly meet these needs is particularly important in a time when the changing climate is impacting on our weather systems," he says.

Visit our website: www.eumetsat.int



Young at gut

Evidence is growing that the microbes in your intestines play a key role in ageing and longevity, as **Scott Anderson** discovers

WHY do we age? As youngsters, we seem invincible. We climb trees, frolic in the dirt and blithely share alarming quantities of mucus. At college, we can thrive on a diet of ramen and beer, party all night and still sit an exam the next day. But in our 30s, we start to wind down. It becomes harder to maintain muscle tone and avoid illness. Our joints start to ache and our memory begins to dim. And it is mostly downhill from there.

People have long attempted to stop or reverse this process. But fountains of youth and secrets of immortality remain firmly in the realms of fiction. Our bodies wear out, even if we no longer do the back-breaking physical labour our ancestors did. And the world seems determined to grind us down with a plethora of disease-causing microbes. To help fend off these pathogens, our bodies recruit other microbes, vast numbers of which reside in our intestines, where we feed them in exchange for their services. But, as we age, this gut microbiota becomes less effective at fighting diseases too.

This raises an intriguing possibility. Perhaps the secret of longevity lies not in the body itself, but in our gut microbes. We still have much to learn about this complex assemblage of bacteria, viruses, fungi and archaea, yet it turns out that people who achieve a healthy old age often have a distinctive gut flora. What's more, we are finding ways to manipulate this world inside us. As strange as it seems, there is gathering evidence that we can increase our lifespan by changing our gut microbes.

Even before you were born, your gut microbiome – the collection of genes that comprise the microbiota – was developing. The uterus was assumed to be a sterile environment, but recent research suggests it contains bacteria and fungi, which are



“Even before you were born, your gut microbiome was developing”

ingested by the growing fetus. At birth, a baby is gifted more gut microbes if it passes through the birth canal. Other early colonisers come from the environment and especially the diet. In another surprising discovery, researchers have found that breast milk also contains a microbiome of its own.

A baby's gut flora is dominated by bacteria that consume milk sugars, especially *Lactobacillus* and *Bifidobacterium*. Other bacteria start to replace these when infants begin to eat solids – although, if the diet contains milk-based foods, a small contingent of the original microbes will remain. Two groups are especially prevalent: Firmicutes, which like to feast on dietary fibre, and Bacteroidetes, which consume sugar and fat. The gut microbiome isn't static, though.

Over time, Bacteroidetes tend to increase in abundance, partly as a result of the global fast-food culture. What's more, antibiotic use in childhood can decimate the microbiota. Although it recovers with time, it sometimes comes back in a less diverse form that, in studies on mice, have been linked with susceptibility to diabetes, inflammation and early death.

At puberty, there is another big change in gut flora, marked by a divergence between the sexes. This timing suggests the shift is influenced by sex hormones: the stable level of testosterone produced by boys and men seems to favour a relatively consistent mix of microbes in the gut, whereas oscillating oestrogen levels are thought to explain why girls and women have a more diverse and

Rejuvenate your gut microbes

How well we age depends on many interconnected factors, including genetics, environment, sex hormones and personal history. Much of this is out of our hands. But a growing realisation that the microbes in our gut also play a part gives us some control over our lifespan and healthspan. Here are a few simple ways you can cultivate a more youthful gut microbiota, starting today:

Value your veggies

Eat plenty of pulses and vegetables, especially ones high in fibre, such as artichokes, asparagus, lentils and onions. Fibre feeds your beneficial microbes. In return, they produce a range of products, including short-chain fatty acids that nourish and heal the gut lining, preventing microbes from escaping into the body and damaging tissues. Some of these microbes also produce neurotransmitters such as dopamine and serotonin that may help to keep your mood on an even keel. So a pleasant side effect of eating well for longevity is that it could also improve your mental well-being.

Get fermenting

Fermented foods include yoghurt, kefir, sauerkraut, kimchi, kombucha and pickles. Before refrigeration, people consumed more of these products because they are resistant to spoilage. This is the result of the natural microbes they contain acting like our own gut microbiota, fighting pathogens and increasing shelf life. This probably also explains why consuming them regularly is linked with longevity and the maintenance of a healthy gut microbiome as we age. Many manufacturers pasteurise fermented foods, killing the beneficial microbes. But a few are catching on to the new microbiota story, and you can find a growing number of these products alive again in grocery stores.

Probiotics in the pipeline

Probiotics are supplements that include live microbes. The most common contain either *Lactobacillus*, found naturally in milk, or *Bifidobacterium*, which is a major component of the mammalian gut microbiome. Taking them can help treat some gastrointestinal conditions and possibly other ailments such as allergies. Probiotics targeted at ageing aren't yet on the market, but growing evidence links certain gut microbes with longevity (see main story). These include *Akkermansia* and *Christensenella*, which should soon be available as supplements.

Pop some prebiotics

Prebiotics are fibre supplements that feed your good microbes. They include inulin, resistant starch, beta-glucan, fructo-oligosaccharide (FOS) and galacto-oligosaccharide (GOS). Each prebiotic has different qualities that make it preferred by specific microbes occupying different niches in the gut. Growing evidence indicates that a diverse microbiota is associated with healthy ageing, so diverse prebiotics are needed to feed them – the same goes for probiotics and fermented foods. Large doses of any of these should be avoided, however, because they can give you abdominal cramps.

variable gut microbiome. This difference may have profound effects. There is a growing realisation that your gut microbes influence your brain and moods, and it has been suggested that differences between the sexes might help explain why psychiatric conditions aren't gender-neutral: why, for example, women are more likely to suffer from depression, whereas autism is far more common among boys and men.

Gender differences aside, microbial diversity appears to be a key factor in longevity and healthy ageing. Earlier this year, a team led by Nathan Price at the Institute for Systems Biology in Seattle reported a study of 9000 adults which found that people's gut microbiota tend to become increasingly diverse and unique with age. This trend continues in healthy people over 80, but not in less healthy individuals. The analysis revealed that a gut microbiome linked with healthy ageing contains fewer bacteria in the genus *Bacteroides*, a member of the Bacteroidetes, and more *Akkermansia* and *Christensenella*, bacteria associated with lower inflammation, better sugar and fat metabolism and a lean body type.

Hallmarks of longevity

These findings resonate with other recent research showing a link between a diverse gut microbiota and healthy ageing. For example, people living in South Korean villages characterised by the longevity of their inhabitants were found to have greater diversity in their gut flora and a higher ratio of Firmicutes to Bacteroidetes. Furthermore, the microbes of centenarians still living independently were more diverse than those living in care homes.

While we can now identify some hallmarks of a gut flora associated with healthy ageing, it isn't yet clear how these microbes might extend a person's lifespan and healthspan. One possibility is simply that microbial diversity increases the chances of your hosting beneficial microbes. Research published in July, for instance, found that a healthy centenarian had a gut microbiome rich in Odoribacteraceae that feed on bile. Bile is produced by the liver and works as a kind of detergent, breaking down dietary fats so they can be absorbed. Most of it is then recycled. But Odoribacteraceae microbes convert some into secondary bile acids, which act as antibiotics



“Microbial diversity is a key factor in longevity and healthy ageing”

against pathogens, including antibiotic-resistant ones, reducing the risk of infection.

The right balance of intestinal microbes might also help physically protect the ageing gut. A healthy gut flora is a resilient ecosystem that treats pathogens as invasive species and typically destroys them upon entry. However, pathogens can sometimes throw it out of balance and then damage the gut lining. That spells trouble because if gut microbes get into the bloodstream, the heart will pump them to every organ, resulting in damage and inflammation throughout the body. We run this risk any time we have an infection or food poisoning, so the longer we live, the greater the odds of this happening. The right balance of gut microbes may reduce these odds.

Another clue comes from a study of healthy

Chinese centenarians which found that their gut flora seemed to enhance their ability to respond to inflammation. Inflammation is the immune system's response to damage. It is always on a razor's edge because it has to react swiftly to kill and mop up pathogens, but also needs to wind down rapidly to limit collateral damage of tissues, which then become inflamed. As we age, the immune system becomes less effective at achieving this balancing act. It isn't yet known exactly how the right gut microbes might help reduce this age-related effect, known as inflammaging, but in recent years it has emerged that gut flora play key roles in the functioning and regulation of the immune system.

Inflammation is at the root of many age-related conditions, including type 2 diabetes,

heart disease, cancer and dementia.

And inflammaging is associated with an unbalanced gut microbiota. But that doesn't necessarily make gut microbes the cause of inflammation. A team at University College Cork in Ireland decided to test this link. John Cryan, Ted Dinan and their colleagues fed middle-aged mice a diet enriched with a prebiotic called inulin, a dietary fibre that increased levels of good bacteria including *Akkermansia*. They were interested in microglia, immune cells of the brain that become plump and mobile as a result of inflammaging, potentially damaging nerve cells. In research published in 2019, Cryan's team revealed that after 14 weeks of the prebiotic, microglia shrunk and hunkered down and inflammation subsided. ➤

A new study goes even further to bolster the link between the gut flora and healthy ageing. This time, the team used faecal transplants to transfer the gut microbes of young mice into old ones. This had a similar effect on microglia and brain inflammation as in the previous study – and some other intriguing results. “It brings about major changes in the biology of the ageing brain,” says Dinan. These include changes in the hippocampus, a region crucial to memory processing and stress responses. In addition, the old mice were better at learning and remembering than they had been before the transplant. “Faecal transplantation from a young to an old animal has a rejuvenating impact,” says Dinan.

“This shows conclusively that the

microbiota is important for healthy brain ageing,” says Cryan. Better yet, it suggests that we might be able to manipulate the human gut microbiome to reduce or even reverse the ravages of time. “These studies point toward a future where there will be a focus on microbiota-targeted interventions that will promote optimum gut health and immunity in order to keep the brain young and healthy,” he says. In fact, the whole body could benefit. “I believe that gut microbiota changes are a major factor in generating frailty,” says Dinan.

But we mustn’t get carried away. Not all mouse studies translate directly to humans, says gastroenterologist Emeran Mayer at the University of California, Los Angeles. “Many factors explain this ‘lost in translation’

phenomenon, including the dramatic brain differences between mice and humans.” He also points out that transplanted microbes usually can’t settle permanently inside the gut ecosystem of another individual because of resistance from the resident flora.

Take back control

“We need to be careful about overselling studies in animals,” agrees Cryan. However, he points to other research showing that faecal transplants cause rejuvenation in worms, flies and fish too. Conversely, faecal matter transferred from old animals to young ones has been shown to lead to cognitive decline. Although we currently lack such cause-and-effect studies in humans, Cryan and his colleagues have shown that rats that receive faeces from humans with depression develop depression-like behaviour too, demonstrating at least some cross-species commonality of the microbiota.

Despite the potential benefits, many people would baulk at the prospect of a faecal transplant. Luckily, there is an alternative. “Several studies give credence to the ability to change one’s microbiota by diet,” says Cryan. “Hopefully, this research will provide an impetus to food companies to develop products that will stave off frailty and cognitive decline in the elderly,” says Dinan. Already there are some hints as to what we should be eating to cultivate a youthful microbiome (see “Rejuvenate your gut microbes”, page 40). “Personally, I have become much more aware of the amount of fibre I take, especially plant fibres,” says Cryan. Dinan thinks the key to maintaining microbial diversity as we age is a varied diet including plenty of vegetables and fruit together with fermented foods and fish.

Billions of dollars are spent each year on diseases of ageing, typically with little recognition of the key role played by the gut flora. Of course, multiple factors affect ageing, so cultivating the correct microbiota is unlikely to be the elixir of youth. But it does hold the promise that we can live longer, healthier lives – not merely adding years to our lives, but perhaps also some life to those years. ■

“We may be able to manipulate our microbiome to reverse ageing”



Scott Anderson is a writer based in Ohio. Follow him on Twitter @Psychobiotic



"We all have the capacity to get into states of mind that we might call evil"

Three decades spent working with the most violent offenders has given forensic psychiatrist and psychotherapist **Gwen Adshead** a unique insight into the nature of crime and punishment.
Rowan Hooper spoke with her

HOW do people come to commit violent and life-threatening acts? Some think such people are innately bad, calling them “monsters” or “evil”. It is a view that William Shakespeare encapsulated in *The Tempest* when Prospero says of Caliban that he is “a born devil, on whose nature nurture can never stick”. But Gwen Adshead doesn’t accept that view. She has spent her career working as a psychotherapist with offenders in prisons and secure psychiatric hospitals, including Broadmoor Hospital, where some of the UK’s most notorious criminals are detained. Rather than seeing violent offenders as being innately evil, she thinks of her patients as survivors of a disaster – where they are the disaster and she is the first responder.

Adshead has published many academic papers and books on criminal mental health. Now, in collaboration with the dramatist Eileen Horne, she has written her first book for a popular audience. It consists of a mosaic of case studies drawn from the many people she has treated over the years. In it, Adshead debunks myths about violent offenders, argues for compassion over condemnation and says that with good mental health care, recovery is possible.

Rowan Hooper: You called your book *The Devil You Know*. Are you saying that we are all capable of evil deeds?

Gwen Adshead: That’s very much where we’re coming from. I became interested in this while working as a therapist and listening to what people who’d done terrible things had to say. These offenders were familiar to me. They were not the “monsters” that I’d read about in the newspaper. They often seemed to be people who were sad and disorganised, and frightened as much as frightening.

It is my very firm conviction that we all have the capacity to get into states of mind that we might call evil. It’s better that we understand those aspects of ourselves. In fact, the more we know about our own inner devils, the better able we are to act in ways that might help people and help ourselves.

Which aspects should we be wary of?

The risk factors for violence include very general things, like being young and male, which are not much help, really, in terms of assessment or intervention. But also more specific kinds of risk factors that could be additive. If you add in substance misuse, if you add in some kinds of paranoid mental illness and then if you add in extreme exposure to childhood trauma, without any support, then you can get to a situation where all these risk factors pile in and generate a level of stress.

The last risk factor that unleashes the violence is often something rather specific to the offender. It can be something that the victim does – which is in no way to blame the victim for what happens – but it may be that the victim doesn’t realise that what they’re doing or saying is having a very specific psychological impact on the perpetrator, who then acts violently.

How important is childhood experience in subsequent violent behaviour?

We really have to take childhood adversity seriously, because there’s such a solid evidence base for that now. A study published in 2019, for example, found that nearly 50 per cent of prisoners in HMP Parc [a prison for men and young offenders in south Wales] had been exposed to a very high level of childhood adversity, which was about five times what you’d expect compared with the general population.

Of course, most victims of trauma will not go on to be violent. It may be that very high levels of childhood adversity – particularly some kinds of adversity, like physical abuse and neglect – can be risk factors for significant violence if they then get combined with substance misuse and serious mental illness or serious mental disorganisation.

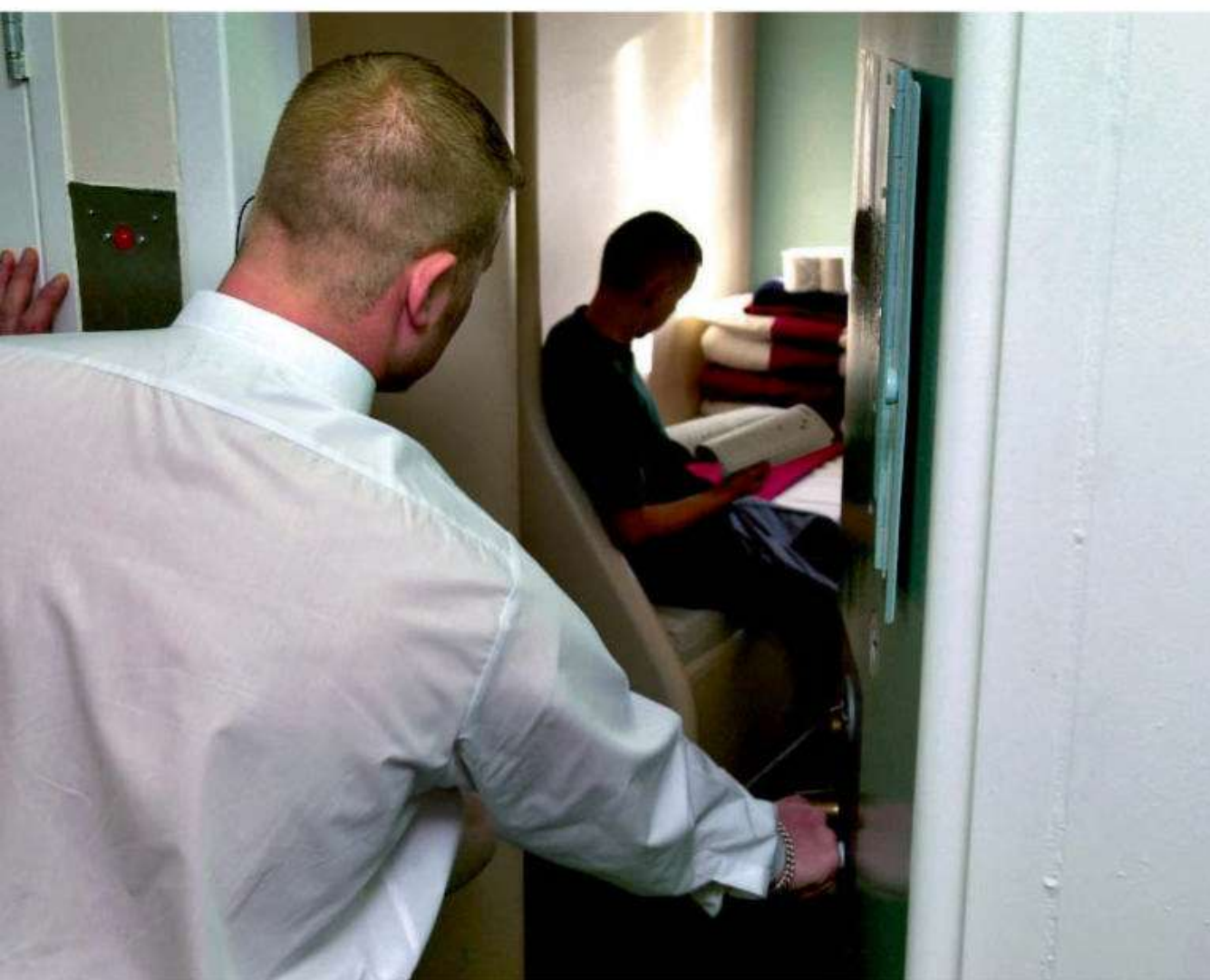
What is your take on the role of genetics in violence?

It’s absolutely clear from the research, over and over again, that nature and nurture interact. The interaction of an environment with a genetic vulnerability can then change that gene to express itself in different ways. But

ADRIAN SHERRATT/ALAMY



“These offenders are not the ‘monsters’ we read about in newspapers”



The risk factors for violent offending include simply being young and male

we have no genes *for* violence. Behaviours arise from the human mind and the journey from synaptic activity to the decision to kill somebody is a very long one.

After decades working with violent criminals, what is your view of human nature?

My view is very much that we have the capacity for goodness, and that is something that has to be worked on, as much as the capacity for cruelty has to be managed and minimised. Most offenders, once they've done something horrible, are keen to learn from what they've done, get themselves into a situation where they're not going to be a risk again and go out and have the usual things that everybody likes. Which is a roof over their heads, someone to love and something useful to do. And those three things are pretty much important to all human beings, and most violent offenders are not exceptions.

How does your viewpoint differ from that of others?

We're fighting against a minority, but one with a loud voice, which says, "no, we don't want to understand, we want to punish and we want to take revenge". While I completely understand the emotions behind that position, I think that

it's probably not feasible or workable in the long term. It's in all our interests that people who have offended get some help to become safer, in terms of not only their mental health, but in terms of their risk to others.

What form does your help take?

I see the mind as a coral reef: ancient, layered and mysterious. My method is simple at one level: I start a dialogue with my patients and provide a space for reflection. But dealing non-judgementally and listening compassionately to people who have committed terrible crimes is by no means easy. The aim, through many sessions of therapy, is to discover the idiosyncrasy at the heart of each person's crime – the particular part of their history and identity that has pushed them into what is often called "evil". I have found that articulating their experience helps many of my patients change and recover. They are able to leave secure psychiatric care and return to prison, and in some cases can be rehabilitated into society.

Media coverage of violent crime might leave people thinking that it is on the rise. Is it?

Every homicide is a tragedy and a disaster, so it's quite right that every one is brought

to public attention, and there's a proper public mourning and a proper public concern. Nevertheless, homicide is a very rare event, and a quite unusual way for human beings to break the law. A study published in April shows that homicide rates in England and Wales have stayed the same for the last 30 years – at about 600 a year or so. In fact, in most countries that have organised social democracies, rates of violence have been falling. Even in prison, violent perpetrators are not the norm, constituting only between 20 and 30 per cent of prison inmates.

What motivated you to write your book?

It is an invitation to come and see a world that people don't often want to look at. The world after the judge has sentenced, after the jail doors have shut, after people have been admitted to a secure setting. I want people to come and see what I see and to learn what I've learned. There is real potential for change and rehabilitation. ■



Rowan Hooper is podcast editor at *New Scientist*. His latest book is *How to Spend a Trillion Dollars*. It is available at shop.newscientist.com



ĐỨC LUONG



Curious craters

Could scars left by ancient black holes smashing through the moon finally provide evidence for elusive dark matter? **Jonathan O’Callaghan** investigates

IF YOU hovered above the surface of the moon and studied it up close, you wouldn’t necessarily see anything special. There would be craters, of course, some dusty slopes and a few featureless, ancient volcanic plains. If you were in the right place, you might get a glimpse of Neil Armstrong’s footprints. But if you knew what to look for, you may find something much more extraordinary than all of this. Hiding on the lunar surface could be a scar left behind by a tiny black hole.

We aren’t talking about any old black holes, but remnants from the dawn of the cosmos. Known as primordial black holes, these theoretical beasts are thought to range in size from the width of a single atom to that of our entire solar system. If they exist, they may explain some of our universe’s greatest mysteries, from the origins of supermassive black holes found at the centres of galaxies to the mysterious planet-like mass at the edge of our solar system. They might even account for dark matter – the roughly 85 per cent of the universe’s mass that we are unable to see, but know must be there in some form.

As yet, there is no evidence that these black holes exist. But now, two physicists have come up with an audacious plan to change that. They want to scour the lunar surface in search of craters left behind as these black holes slammed into – and indeed through – the moon. “It sounds a little bit wild,” says Matthew Caplan at Illinois State University. “But you never know until you check.”

The idea of primordial black holes dates back to the 1970s, when Bernard Carr, now at Queen Mary University of London, was working alongside Stephen Hawking. The pair suggested that in the early moments of the universe, shortly after the big bang, some

pockets of space became so dense that they collapsed and formed black holes, in much the same way that we believe some stars explode and collapse into black holes today.

In 1974, Hawking put forward the notion that came to be known as Hawking radiation, the idea that black holes might lose mass and evaporate over time. As they get smaller, the theory says, they lose mass more quickly until they end their lives in an explosion. “That’s why there was such interest in primordial black holes, because if they exist, we might see them exploding in the present epoch,” says Carr. Evidence wasn’t forthcoming, however, so interest dwindled.

Black hole revelations

In recent decades, the idea has been renewed as larger primordial black holes – which could have persisted to the present day – were proposed as possible answers to a few of the questions that keep astronomers and cosmologists up at night. A primordial black hole crashing into Earth has been touted as an explanation for the famous 1908 Tunguska event, for instance, which saw a large explosion over Siberia that many believe was due to a meteor. Another idea is that the elusive Planet Nine, which is thought to reside at the edge of our solar system, might not be a planet at all, but a black hole.

Perhaps the most intriguing notion is that dark matter could be made of these primordial black holes. So far, efforts to detect possible dark matter particles, such as the proposed weakly interacting massive particles (WIMPs), have come up empty. “A lot of people have spent their lives looking for some form of elementary dark matter ➤

particle,” says Carr. “But the fact is we haven’t found those particles.”

Primordial black holes offer an intriguing alternative. “What’s nice about them is you don’t need any new particles,” says Charles Horowitz at Indiana University Bloomington. “It’s just normal matter and density fluctuations when the universe was very young.”

Primordial black holes could also explain the detection of about 20 unknown lensing objects – unexplained clumps of mass causing light from distant stars to bend around them – studied by the European Space Agency (ESA)’s Gaia satellite. They seem like stars, but aren’t visible. “We are slowly getting glimpses that primordial black holes might really be there,” says Günther Hasinger, director of science at the ESA.

At the same time, evidence from the detection of gravitational waves has hinted that black holes could exist in a wider variety of masses than we had thought, raising the possibility that others – potentially with lower masses – could be found. While studying black hole mergers in its hunt for gravitational waves, the Laser Interferometer Gravitational-Wave Observatory (LIGO) has detected black holes that seem to be as low as 2.6 times the mass of our sun, an unexpectedly low mass

The surface of the moon is littered with craters of many shapes and sizes

for black holes. “If LIGO sees black holes that are smaller than the mass of the sun, that will be pretty convincing evidence of something primordial,” says Maya Fishbach, a LIGO team member at Northwestern University in Illinois. “We don’t know of any evolution process that can create a compact object that small.”

While this is promising, none of it is concrete evidence. But this is where Caplan and his colleague Almog Yalinewich at the Canadian Institute for Theoretical Astrophysics

“It sounds a little bit wild, but you never know until you check”

in Toronto come in. “Our idea is to use the moon as a detector,” says Yalinewich.

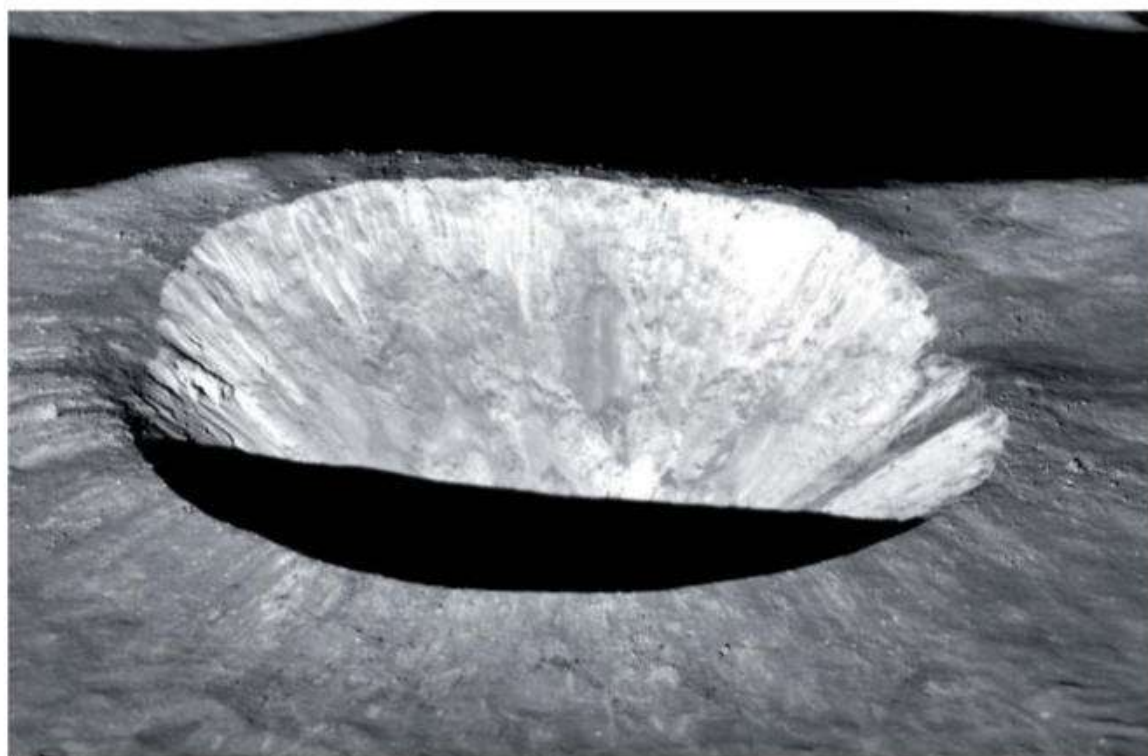
This is undoubtedly a bizarre idea, but the science behind it seems sound. If our universe produced copious amounts of primordial black holes in its infancy, it is plausible that some have persisted to the present day, pervading the universe and perhaps regularly

passing through our solar system. If so, they may have hit some of our celestial bodies, such as the moon, leaving a telltale crater behind.

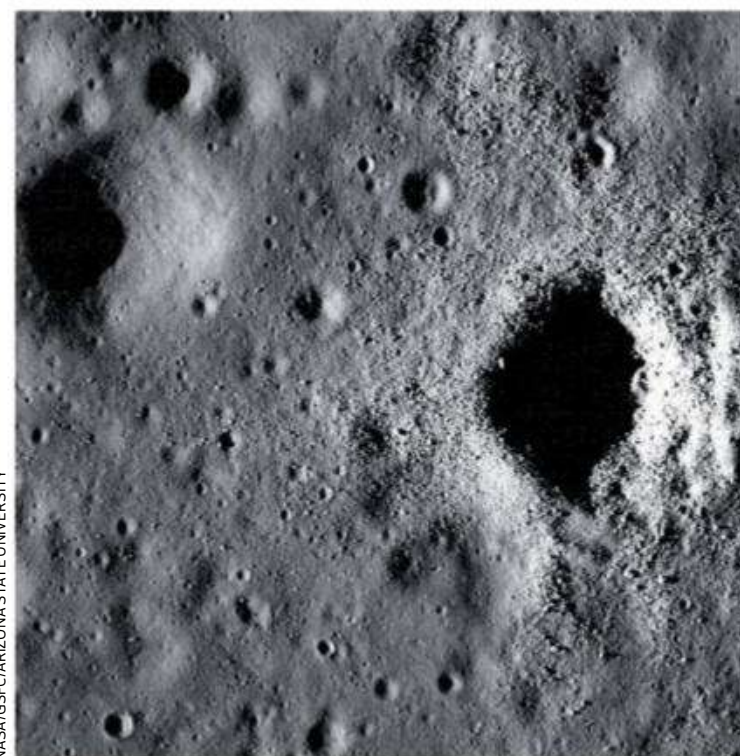
But how big would such a crater be? That depends on the size of the black hole. Astronomers searching for primordial black holes have mostly ruled out certain masses – too small and they would have evaporated by now, too large and we would see the effects of their gravity on distant stars. In a study published in July, Yalinewich and Caplan considered those in the middle – roughly the mass of an asteroid, between about 10^{16} and 10^{19} kilograms, but with the radius of an atom.

In this scenario, up to a few hundred primordial black holes would be expected to pass through our solar system every year, some hitting celestial bodies. For worlds such as Earth that have been resurfaced by weathering and geological activity, any evidence of an impact would have been erased. But for airless bodies like the moon, scars could remain – even after billions of years.

What would these scars look like? If such a black hole hit the moon, it would temporarily create a small molten tunnel through its 3500-kilometre-wide bulk, which it would cross in seconds, with temperatures of maybe 100,000 degrees kelvin, Yalinewich calculated. “They’re going at incredible speeds, 200 kilometres a second,” says Caplan. “It’s like a bullet punching through cotton candy.” These tunnels would quickly cool, leaving only small,



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Studying the movement of galaxies like these could reveal if dark matter exists

detectable entry and exit points on the surface in the form of a small crater 1 metre wide.

While there are millions of craters this size on the moon, a black hole crater would have a noticeable difference: the ejected debris, which would extend several metres around the crater, would form a much steeper slope than a regular crater. This is a result of the black hole being a million times denser than the moon and passing clean through without slowing down. “Because the object doesn’t decelerate, it imparts a different velocity onto the ejecta,” says Yalinewich.

By scouring through high-resolution images of the lunar surface from orbiting spacecraft, such as NASA’s Lunar Reconnaissance Orbiter, we might be able to spot such a crater. Given there are millions of other metre-wide craters, that could take some time if done by hand, so Yalinewich and Caplan plan to use machine learning tools. “If we are successful in training a machine to find them, I expect to see results within three years,” says Yalinewich.

If these craters do exist on the moon, there will be two implications. Firstly, they could provide tantalising evidence that primordial black holes do exist after all. “That would be a Nobel prize I’m sure,” says Christian Byrnes at the University of Sussex, UK. Secondly, they could help prove whether primordial black holes are responsible for dark matter. According to Yalinewich, if a primordial black hole turns up on the moon, despite the relatively slim odds, it suggests they are abundant enough in the universe to account for at least some of the dark matter we have observed. But we would need to find them elsewhere to be completely sure.

Yalinewich and Caplan know their chances of success are remote. Even in this best-case scenario, where all primordial black holes are roughly the mass of an asteroid, there is only a 10 per cent chance one would have hit the moon. In reality, it is much more likely that they span a wider range of masses, which reduces the chances of us finding a crater.

There may be another hurdle. David Minton at Purdue University in Indiana says the pair have overestimated how long small craters would remain on the moon. Rather than persisting for billions of years, Minton thinks a crater 1 metre in size would probably be erased within just 13 million years as the lunar surface is reshaped by frequent meteorite impacts. “The constant bombardment of small

meteoroids causes a constant churning of the surface of the moon,” he says.

Yalinewich agrees that this could make the identification of such craters more complicated. But his simulations found that the ejecta around the impact, which would persist for longer, should still be noticeably different than one formed by a meteorite impact.

“A black hole impact would be like a bullet punching through cotton candy”

Such identification might be exceedingly difficult due to the sheer number of craters on the moon, says Mohamad Ali-Dib at New York University Abu Dhabi, who has developed his own machine learning tools to study lunar craters and uses them to probe the history of the solar system. “You can probably find whatever properties you want, but it’s not

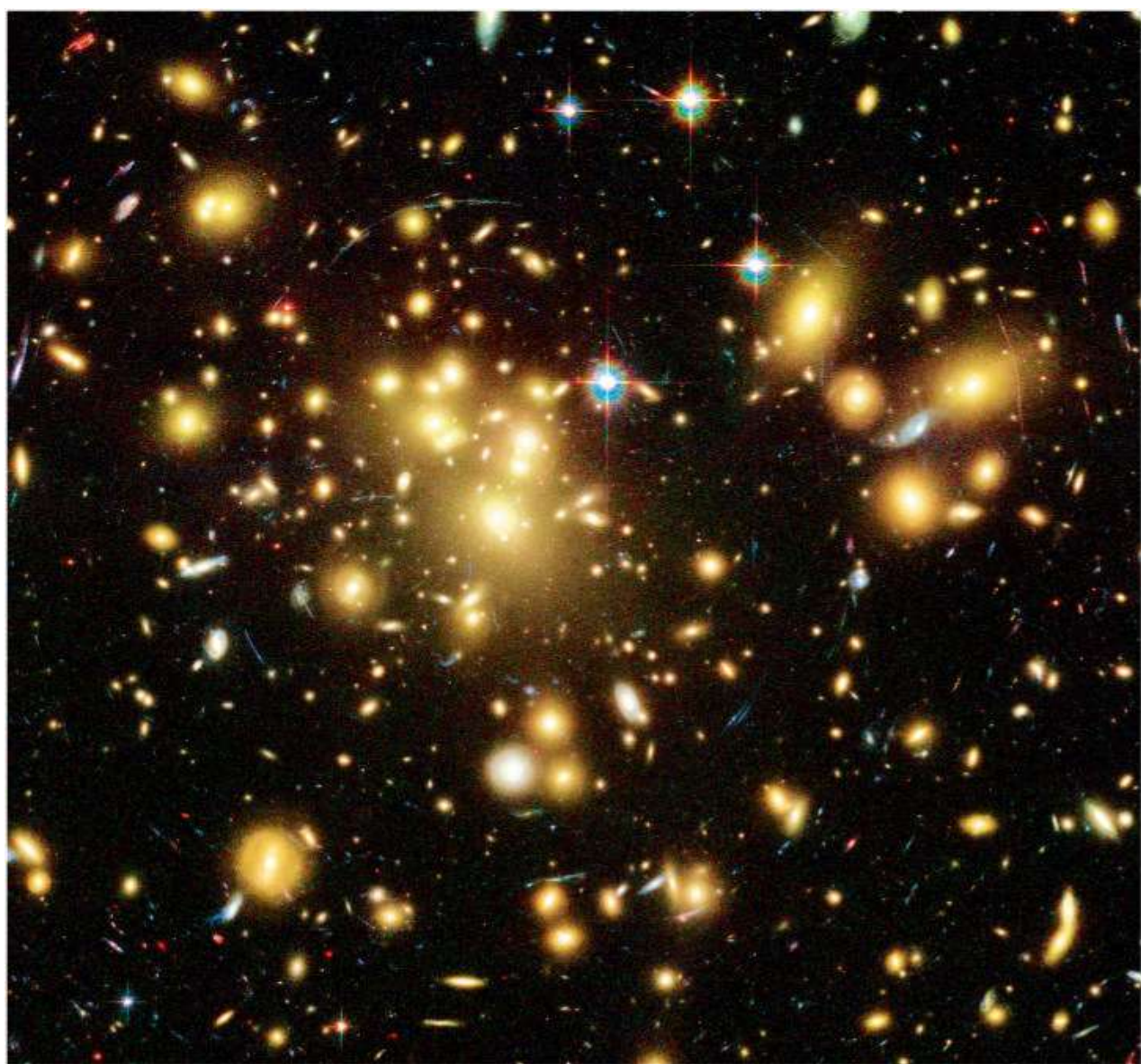
necessarily due to a black hole,” he says.

To truly confirm if a crater with suitable properties were formed by a black hole, it would need to be studied up close. An astronaut with ground-penetrating radar, for example, could look for a column of “messed-up matter” beneath the crater, says Caplan. The surface of the centre of the crater, meanwhile, could be sampled. With a primordial black hole punching through, “it gets hilariously hot, enough to make new phases of silica and quartz you could look for”, he says.

And if nothing turns up on the moon, that doesn’t mean the search is over. The same technique could one day be applied to other airless bodies, if we get sufficiently good imagery. Mercury could make a good target, as could Mars and Pluto, or even the rocky moons of Saturn and Jupiter. For each, the chances of seeing a crater ranges from 5 to 23 per cent, say Yalinewich and Caplan, but taken together, the odds increase. “If you look at the combined surface area of all these,” says Yalinewich, “you should expect at least one of these exotic craters to appear.” ■



Jonathan O'Callaghan is a freelance writer based in London



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Stargazing at home

Jump to hyperspace

Learn your way around the stars with **Abigail Beall's** guide to star-hopping from Cassiopeia



Abigail Beall is a feature editor at New Scientist and author of *The Art of Urban Astronomy* @abbybeall

What you need

Clear night skies

A telescope (optional)

Binoculars (optional)

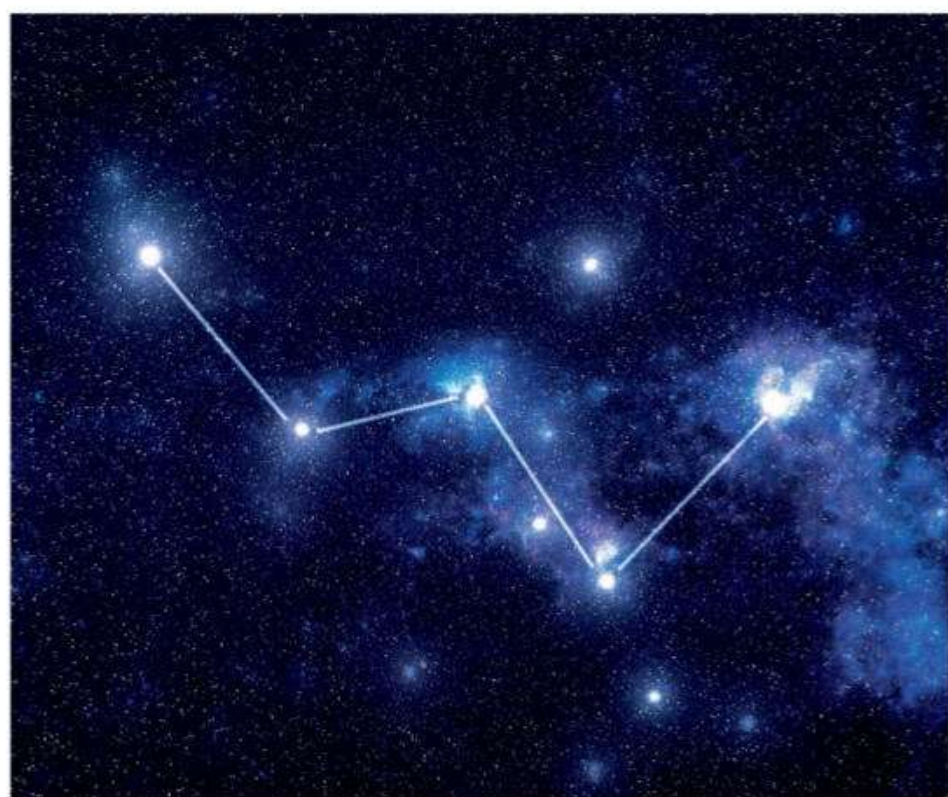
THERE are some constellations you only need to learn once, then you can spot them for the rest of your life. Others are more difficult to find, and you might need some help to work out what they are. This week, we are using an example of the former – the mid-sized but distinctive Cassiopeia – as a jumping-off point to explore further.

While Cassiopeia is a northern hemisphere constellation, at this time of year, it can be seen from northern parts of the southern hemisphere too, as far as 20 degrees south. Its position near the north star, also known as Polaris, means it is visible from the northern hemisphere all year.

Cassiopeia contains five bright stars in a W or M shape, depending on where you are looking from. Of the two upright or inverted Vs that make up the constellation, one is noticeably deeper than the other. To find Cassiopeia, no matter where or when you are looking, a good place to start is by facing north. The constellation won't be far away.

Cassiopeia is a great constellation to identify on its own, but the lovely thing about it is that it is essentially made up of three arrows that point us towards other objects in the sky.

First, check out the constellations Andromeda and Pegasus. To find them, use the three stars in the deeper of Cassiopeia's two Vs. If Cassiopeia looks like an M to you, this is on the left, and if it looks like a W, it's on the right.



ALEXANDRYURTCHENKO/ALAMY

Follow an imaginary line from the V's point, and the line of bright stars that you come to will be the Andromeda constellation. Between Cassiopeia and the first bright star lies the Andromeda galaxy, the closest galaxy to us, which is visible to the naked eye if it is dark enough. Perpendicular to your first imaginary line, away from Cassiopeia, is a large square of stars. This is the Great Square of Pegasus, an asterism that is part of the Pegasus constellation.

Looking in the other direction, and using the middle three stars of Cassiopeia as another arrow, the first constellation you will find is Cepheus. Beyond Cepheus will be the north star, which sits in the constellation Ursa Minor. Looking further still from Ursa Minor, you should see the Plough or the Big

Dipper, which is part of Ursa Major.

For a third star-hop from Cassiopeia, draw a line from the middle star to the one to its left if it looks like a W, or to the right if it looks like an M. Keep going and you will get to a line of three stars. This is the top edge of the constellation Perseus.

Go a little further in the same direction and you should see the Pleiades star cluster, a tiny group of stars that looks a little like the shape of the Big Dipper. If you have found the Pleiades, you are at the end of Perseus and into the constellation Taurus.

Try these three star-hops next time you have clear skies. ■

Stargazing at home appears every four weeks

Next week

Science of gardening

These articles are posted each week at
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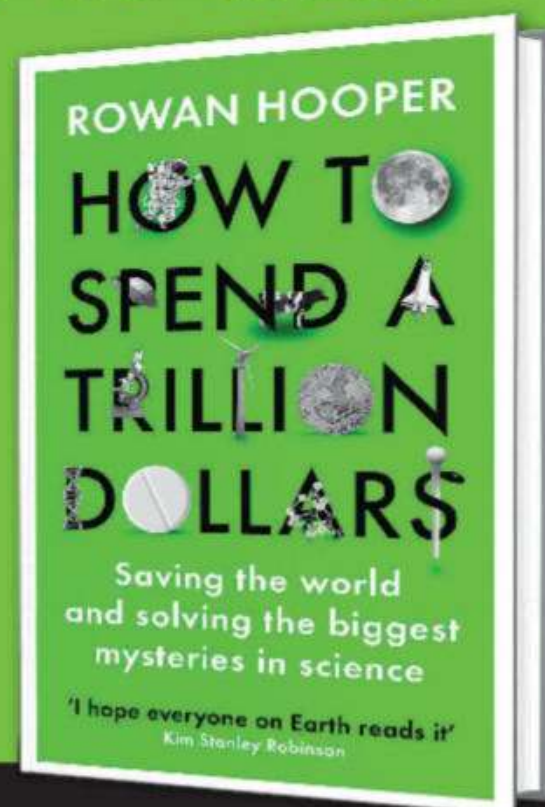
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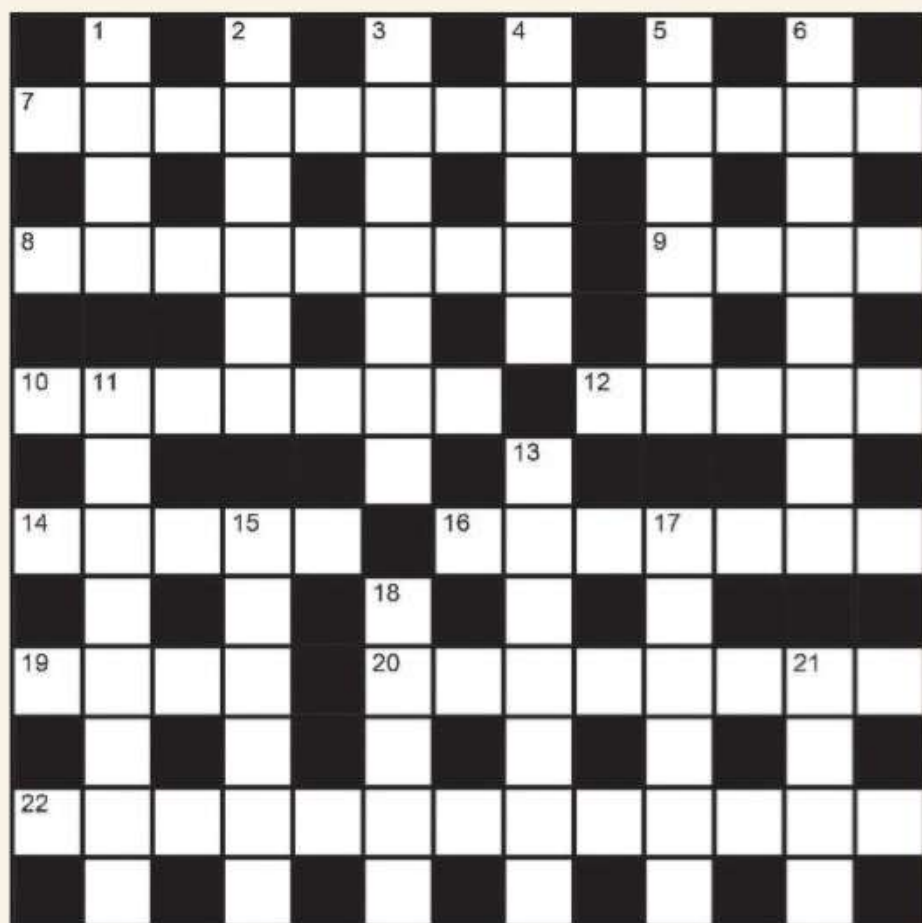
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Scribble zone

Answers and the next quick crossword next week

ACROSS

- 7** Gold found in a rich planet orbiting triple star system (5,8)
- 8** What rockets carry, as executive salaries do? (8)
- 9** US city drops out of most recent assessment (4)
- 10** Persist in listening for dead animals (7)
- 12** Characteristic of titanium creative work reflected (5)
- 14** Attempts thrusting movements (5)
- 16** Philosopher's rotten meat (7)
- 19** Release parasite back to front (4)
- 20** A banned substance that could be found in belt? (8)
- 22** Dominant theory expressed by one posing behind London paper (8,5)

DOWN

- 1** Overheard: "Go away, pest" (4)
- 2** Humour shown by cave research leaders crossing abyss (6)
- 3** Go on, act out shape (7)
- 4** Herb partially vulcanised (5)
- 5** Duller substance (6)
- 6** Metal starts to increase cheesy aroma in cabbage? (8)
- 11** Addicts go around university with endless fruit machines (8)
- 13** Organic molecule has energy carried by movement of water (7)
- 15** Sticks gases in flying animals (6)
- 17** A bit of muscat or port brings a state of inactivity (6)
- 18** Military technology runs around Lovelace, maybe (5)
- 21** I exist on unknown goat (4)

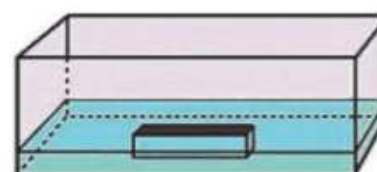
Quick quiz #121

- 1** What name is given to the process through which plants naturally shed leaves, flowers and fruit?
- 2** Who proposed the "plum pudding" model of the atom?
- 3** What is the brightest star in the constellation Aquila?
- 4** How are the feet of the osprey different from those of most other raptors?
- 5** What was the name of Charles Babbage's proposed mechanical general-purpose computer?

Answers on page 55

Puzzle

set by Barry R. Clarke
#133 Think tank



Toddler Tina has noticed that Sticky, her stickleback, is struggling because the water in the slim fish tank is only 2 centimetres deep. She would like to top up the tank with water, but the tap is beyond her reach, so she has the bright idea of dropping one of her toy bricks into the tank instead.

Fortunately, the brick misses the fish, and the water level rises to become exactly level with the height of the brick, which is lying flat. The brick is twice as long as it is wide, and three times as long as it is high. The interior of the tank is one-and-a-half times as long as the brick, but only two-thirds as wide as the length of the brick.

What are the dimensions of Tina's toy brick?

Solution next week



Our crosswords are now solvable online
newscientist.com/crosswords

Tied up

What is the best way to tie shoelaces? Mine never stay tied for very long.

Hazel Russman

London, UK

The bow often used for shoelaces is essentially a double knot, but using folded loops rather than straight ends for the second knot.

Double knots come in two kinds: the reef knot and the granny. A reef knot is symmetrical, with the two single knots tied in opposite directions, whereas in the granny knot, they are tied in the same direction. Granny knots are harder to untie deliberately, but they often slip spontaneously under tension.

To tie your shoelaces more securely, you therefore need to ensure that the two knots are tied in opposite directions.

Clive Tiney

Haxby, North Yorkshire, UK

After 55 years of tying my laces the way I was taught, I realised I was

“The challenge is to overcome 50-plus years of muscle memory which enables me to tie laces without thinking”

tying a granny knot, which can come loose readily.

I started tying a reef knot as an experiment and found that my laces rarely come undone, irrespective of whether they are flat ribbons or round.

The challenge now is to overcome 50-plus years of muscle memory which enables me to tie without thinking.

Mike O'Neill

Wokingham, Berkshire, UK

My laces used to come undone regularly until I saw a suggestion in *New Scientist* a few years ago. You form a loop with one end of the lace as usual, turn the other end around it twice, not once, then



FIONA MCGREGOR

This week's new questions

Beach blob What is this object (pictured), found in the surf off the Isle of Mull in Scotland? It was originally dark and got lighter as it dried out. It has an odd smell.

Fiona McGregor, London, UK

Purrfectly formed Cats were domesticated in ancient Egypt, yet unlike other domesticated animals, don't seem to have evolved significantly since. Why?

Ian Ferguson, Dawlish, Devon, UK

loop that end, push it through as usual and pull tight.

It is a bit more fiddly, but I can't remember them ever coming undone.

Angela Cotton

Southampton, UK

Last year, my mother (aged 93) taught me the more secure technique for tying laces, which entails wrapping one lace twice around a loop formed by the other end of the lace, then forming a bow and completing the knot. I find it so technically difficult that I often revert to my old method, but my brother was sufficiently impressed that he mentioned it during her eulogy later that year.

Also, use flat laces, as in my

experience they are less likely to come undone than rounded ones.

David Beckett

Clonlara, County Clare, Ireland

My 10-year-old granddaughter has the answer. She ties her rugby boots leaving the ends short, and the long loops are then tucked under the criss-cross lacings in the direction of the toes, and out of harm's way.

I use the method when cycling, as laces can sometimes get caught in the chain.

Matt White

Sydney, New South Wales, Australia

I suggest an excellent website, fiegggen.com/shoelace/knots.htm, by Ian Fiegggen. I have already been

What is this strange disc recovered from the sea off a Scottish island?

converted to Ian's Secure Shoelace Knot (Double Slip) for everyday use. It is a "bunny ears" knot with an extra twist that works very well, and importantly undoes easily. There are lots of other interesting knots here too.

Chris Robinson

London, UK

I recently stumbled across a TED talk that informed me I had been tying my shoelaces wrongly all my life. When tying the bow, after forming the first loop, pass the lace behind rather than in front of the loop to form the second loop.

A year on I can verify this works, and there is no need to use a further knot.

Mike Follows

Sutton Coldfield,

West Midlands, UK

The problem of accidental untying of shoelaces has been investigated by researchers at the University of California, Berkeley. They discovered that the impact of the shoe on the ground loosens the knot, while the whipping of the free ends of the laces as your legs swing back and forth makes the laces slip loose. So laces should be kept as short as possible to minimise their mass and hence the force tugging on the knot.

Given that we usually get taught how to tie laces by our parents, so probably see the demonstration upside down and back-to-front, I wonder whether alternate generations of each family tie their laces incorrectly?

Expansive objects

Physics tells us the universe is expanding in all directions. Does this include atoms and objects, such as me? (continued)

Alan Bundy

Edinburgh, UK

The previous correspondence on the topic about expanding atoms



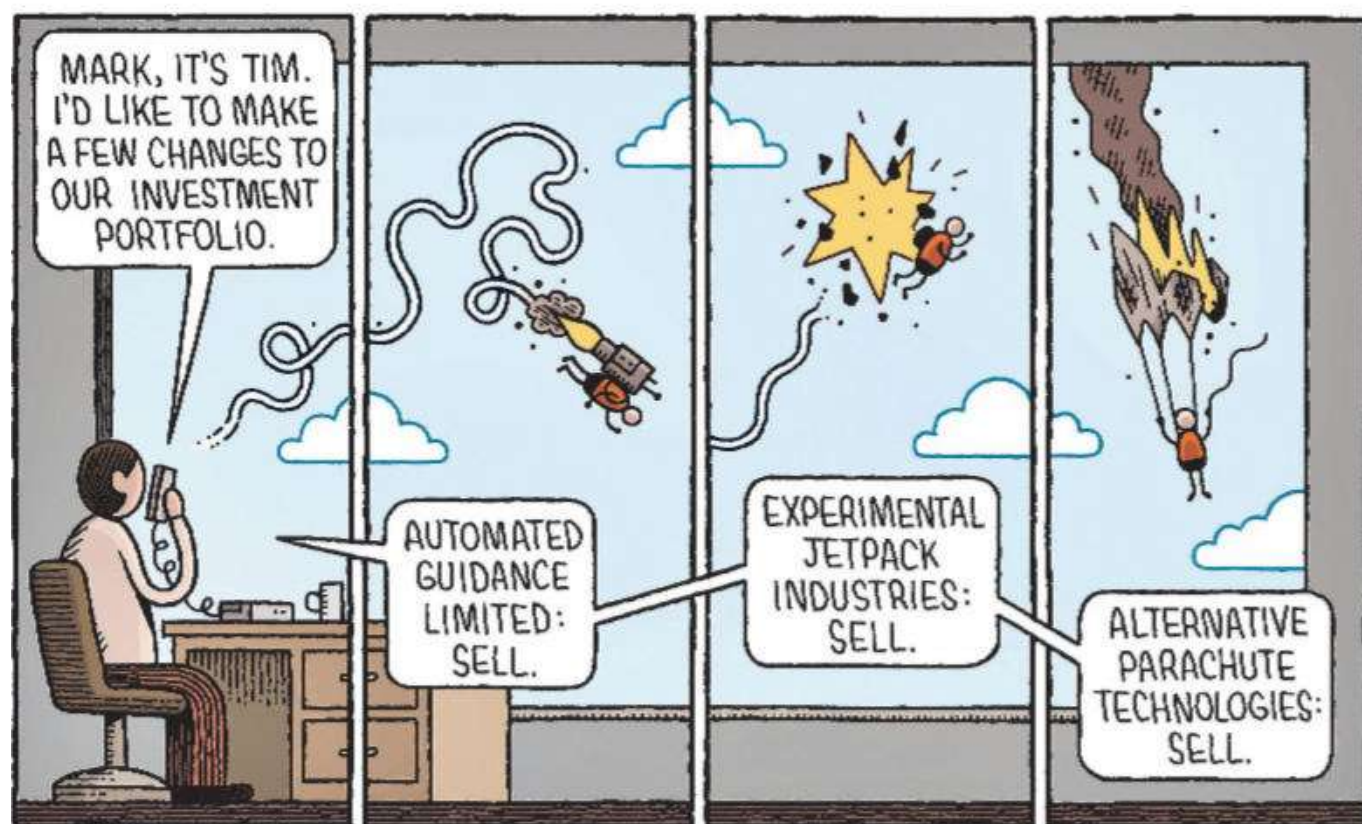
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Tom Gauld
for New Scientist



TOM GAULD for NEW SCIENTIST

(3 July) missed the point of the question. If all the atoms in the universe were expanding at the same rate as space-time, then we wouldn't be able to detect any expansion.

Philip Brown

Peterborough, Cambridgeshire, UK
In this case, I don't believe that the questioner wanted to know whether the expansion of himself was perceptible, rather the question is whether his atoms (and consequently himself) were in any real sense expanding, or whether they are simply moving further apart while remaining the same size.

Perhaps the answer is that the size of particles is fixed relative to the granularity of space-time, so the answer is yes or no depending on how you look at it.

Nigel Charman

Via email

The previous responses to this question outlined that, since the expansion of the universe is so slight in local terms, it can only be detected over large times or

"If all atoms in the universe expanded at the same rate as space-time, then we wouldn't be able to detect any expansion"

distances. They therefore concluded that it doesn't affect you or your atoms.

Surely this is wrong. It doesn't affect them much, but every cubic metre expands the same amount over the same time. It was quoted that a ruler that is 1 metre long might be expected to expand by about 2×10^{-18} metres every second, which is admittedly small, but, yes, you are expanding. You just would never be able to tell.

Derek Bolton

Sydney, New South Wales, Australia
If the distances between all the entities in the universe expand at the same rate as the universe as a whole, there would be no way to detect the expansion. The problem would be that whatever you use as your unit of distance would expand too.

A low bow

I saw a strange rainbow, at the wrong height compared with a normal one. It is supposedly impossible to see a rainbow at any other angle than around 42 degrees, but the arc of my "low bow" looked like 21 degrees. Can anyone explain? (continued)

Ed: The previous letters about this "low bow" (31 July) concluded that it must have appeared when the sun was high in the sky. However, Guy Cox, who spotted the low rainbow (pictured), has clarified that it occurred in the late afternoon, when the sun was close to the horizon. He has photographed a "normal" rainbow at a similar time and season, so the sun's elevation can't account for the effect. The mystery continues. Any ideas? ■



Answers

Quick quiz #121 Answers

- 1 Abscission
- 2 J.J. Thomson
- 3 Altair
- 4 They are zygodactyl, with two toes that point forwards and two that point backwards
- 5 The Analytical Engine

Quick crossword #92 Answers

ACROSS 8 Umbo, 9 Laboratory, 10 Suture, 11 Symptoms, 12 Woodcock, 14 Inches, 16 Boom, 17 Nails, 18 Dopa, 19 Bypass, 21 Ladybird, 23 Project X, 26 Legume, 27 Watson-Watt, 28 Etna

DOWN 1 Immunology, 2 Corundum, 3 Albedo, 4 Ebbs, 5 Gremlins, 6 Static, 7 Gram, 13 Krill, 15 Experiment, 17 Nose cone, 18 Debugged, 20 Adjust, 22 Delete, 24 Read, 25 X-ray

#132 One of these days Solution

The quiz will be on Thursday. If it were on Monday, statement A would be false, B would be true and D would be true, making C false. Now, E can't be true, because then it would become false, and it can't be false, because then it would become true.

So there is a contradiction, telling us it can't be on Monday. Similar logical contradictions exist for the other days except Thursday.

In vino veritas

There is science that changes the world, and there is science that just makes the world a better place. Feedback would put a recent paper in *PLoS One*, “The power of Dionysus—Effects of red wine on consciousness in a naturalistic setting”, in this second category.

Rui Miguel Costa and his colleagues at the Institute of Applied Psychology in Lisbon got participants either singly, in a duo or as a group of six to consume two glasses of Quinta da Lapa Reserva Syrah 2018, “a silky full-bodied red wine from the Lisbon region with 14° of alcohol”, in a Lisbon wine bar. They were then asked to fill in a questionnaire probing changes in their state of consciousness.

Apologies to the sun-deprived for whom the word “Lisbon” may have appeared one or three too many times in that paragraph. We make no such apology for reporting the study’s results in detail. “Red wine increased pleasure and arousal, decreased the awareness of time, slowed the subjective passage of time, increased the attentional focus on the present moment, decreased body awareness, slowed thought speed, turned imagination more vivid, and made the environment become more fascinating,” the researchers found. “Red wine increased insightfulness and originality of thoughts, increased sensations of oneness with the environment, spiritual feelings, all-encompassing love, and profound peace. All changes in consciousness occurred regardless of volunteers drinking alone, in dyad or in group.”

“Does that mean red wine mystically gives you the effects of being drunk?” a colleague asks, possibly sardonically. We aren’t sure, as we are on deadline, and we have been doing what it takes to increase our attentional focus on the present moment.

One size fits all

Just as our imagination is turning more vivid, we encounter an

Twisteddoodles for New Scientist



Got a story for Feedback?

Send it to feedback@newscientist.com or New Scientist, Northcliffe House, 2 Derry Street, London W8 5TT
Consideration of items sent in the post will be delayed

article sent in by Michael Zehse about clothing brand Petit Pli. The brainchild of Ryan Mario Yasin, described as a former satellite engineer, the USP of this children’s clothing is that it expands to fit.

“Ryan used origami principles that engineers use to fold up satellites to help design items that could open up and fit children as they grow,” the article reports. “The items are so effective that they will fit a nine-month-old baby until they are four years old.”

A cracking idea, especially as apparently the process is reversible at will. We haven’t quite worked out yet how inflation and deflation works, but we like the idea of, for example, being able to inflate a child for added safety and security in a play area. We are slightly more concerned about the prospect of accidental activation

either way. Mind you, we are sure they have cracked that one in space.

Feel the burn

Also innovative in the clothing department is the Craghoppers Dynamic 12000 jacket, for which Jem Moore spots an ad. Its “unique feature is the mesh lining made from six natural minerals”, it claims.

We would pay more for a mesh of unnatural mineral, say of unobtainium, but we’ll settle for the natural ones since they “reflect your body’s own infra-red rays”.

We think this is a fancy way of saying “keep you warm”. All in all, however, we are rather too taken with the idea of combining this with inflation and deflation technology. Do it fast enough and you could probably generate some pretty sizable Doppler shifts in the reflected radiation, perhaps turning

your body heat into visible light, say. We haven’t done the maths yet, but we are sure this is right, as we enter a phase of profound peace and all-encompassing love.

Thickly spread

In which condition, we offer our belated congratulations to the state of Western Australia for launching its first satellite on 29 August. Propelled aboard a SpaceX Dragon spacecraft from NASA’s Kennedy Space Center in Florida towards the International Space Station, the satellite is described in an ABC news article forwarded to us by Brian Horton of (presumably fuming) Tasmania as “not much bigger than a vegemite sandwich”.

We have seen pictures of the cuboid satellite, and we can’t help thinking that is one thick vegemite sandwich. We understand the need to celebrate this giant leap for Western Australian spacefaring with a suitably patriotic measurement, but this one lands on our rapidly growing pile labelled “Suspect Units (Australia)”.

Elephant hunting

Many thanks to all of you who came forward with suggestions for how scientists in various disciplines would find an elephant, in the room or elsewhere (4 September). John Maybury suggests that physicists might like to build a hugely expensive Large Mammal Collider to try to make elephants from hippos, rhinos and the like.

In full sobriety, meanwhile, Peter Ashby opines: “As a Developmental Biologist I would detect an elephant by following it back into development. Only if it develops like an elephant can it be an elephant.”

Full sobriety is not where we are by now. That’s why we also include an old joke sent in by Natalie Roberts: “How do you hide an elephant? Paint its toenails red and stick it in a cherry tree.” We’ve had quite enough now, and we are sure you have too. ■

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